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NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

SKIPPING A GENERATION OF WEAPONS SYSTEM
TECHNOLOGY; THE IMPACT ON THE DEPARTMENT OF
DEFENSE AND THE DEFENSE INDUSTRIAL BASE

by

Thomas A. Atkinson

March 2003

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**SKIPPING A GENERATION OF WEAPONS SYSTEM TECHNOLOGY; THE
IMPACT ON THE DEPARTMENT OF DEFENSE AND THE DEFENSE
INDUSTRIAL BASE**

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Submitted in partial fulfillment of the
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MASTER OF SCIENCE IN MANAGEMENT

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ABSTRACT

During the 2000 presidential race, then Texas Governor George W. Bush advocated transforming and reforming how the Department of Defense (DoD) acquires new weapon systems. He promised a "revolution" that would "skip a generation of technology," in order to "move on to futuristic weapons without necessarily buying all those in development." This thesis examines President Bush's proposal and analyzes the potential impact on DoD and the defense industry. Ultimately the research revealed that there are ways to improve the acquisition process and protect the defense industry. The primary conclusion of the research is that it is feasible to skip current weapon systems in development, in order to begin research and development of the next-generation weapon systems. However, DoD will be impacted through higher operations and sustainment (O&S) costs to sustain existing weapon systems if weapon systems currently in development are skipped. The acquisition professionals that participated in this study believe these O&S costs could increase up to 10% per year for anywhere from five to 20 years depending on the type of system. This thesis makes additional recommendations and areas of further research.

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I. INTRODUCTION

A. PURPOSE

This thesis examines President George W. Bush's proposal to skip a generation of weapons system technology currently in the Department of Defense (DoD) development and procurement process, and determines the potential impact the proposal will have on DoD and the defense industry. To accomplish this goal, the reader will be given the necessary background knowledge of the DoD acquisition process and an understanding of how DoD develops and assesses mature technology. Furthermore, this thesis will establish how long a generation of technology lasts for different types of weapon systems and define what "skipping a generation of technology" means. The ultimate goal of this study is to uncover the feasibility of skipping current weapon systems in development, in order to begin research and development of the next-generation weapon systems. The research results are examined and recommendations provided to help effectively implement this proposal, in order to maximize DoD funding and our defense industrial base.

B. BACKGROUND

In the 1990's, the collapse of the Soviet Union, the rapidly changing threat environment, reduced resources, and changes in technology development, significantly effected the Department of Defense and how it acquired new weapon systems. DoD's share of the federal budget went from 27.3% of federal outlays in 1987 to 15.9% in 2002 (FY 2003

Defense Budget 2003, p. 217)). In constant dollars, DoD funding steadily declined from a peak in the mid-1980s until the beginning of the twenty-first century when the funding trend started to reverse. The steady decrease in DoD funding resulted in Secretary of Defense William Perry's Acquisition Reform Initiatives and three major congressional acquisition reform acts between 1994 and 1996.

The Introduction To Defense Acquisition Management (IDAM) Fifth Ed., states that the Department of Defense's vision of Acquisition Reform is: "DoD will be recognized as the world's smartest, most efficient, and most responsive buyer of best-value goods and services that meet our warfighters' needs from a globally competitive national industrial base (IDAM, 2001, p. 15)." Implementing this vision means taking advantage of the best commercial items and practices, awarding contracts based on best overall value, looking at cost as an independent variable, and fostering cooperation and teamwork among all functional areas in product development. DoD's reforms significantly streamlined systems acquisitions and forced DoD to make trade-offs and look for already existing or cheaper alternatives. However, DoD's budget has reached its lowest point as a percentage of Gross National Product since 1940 as competing domestic priorities have siphoned some of its funds. As we move further into this decade, more acquisition reforms seem inevitable.

During the 2000 presidential race, then Texas Governor George W. Bush advocated transforming and reforming how the Department of Defense acquires new weapon systems. Bush

promised a "revolution" that would "skip a generation of technology, (Cohen, 2000, p. 41)" in order to "move on to futuristic weapons without necessarily buying all those in development (Thompson, 2002)." George W. Bush won the 2000 Presidential Election and was inaugurated in January 2001. Shortly thereafter, President Bush made good on his campaign promise by proposing \$2.6 billion more dollars for DoD research and development in his 2002 budget "as a down payment on the research and development effort that lies ahead (Ruddy, 2001)."

President Bush's initiative targets many weapon systems currently in procurement, some designed to fight the old Soviet Union. His initiative would cancel these outdated systems and reallocate the funding to develop and field weapon systems capable of fighting America's emerging threats using next-generation technology. For defense contractors, this initiative could mean billions of dollars in lost revenue and "is causing jitters in the aerospace industry and the stock market (Asker, 2001)." Weapon systems currently under development that may be skipped span all DoD Departments and include the F-22 Tactical Fighter Aircraft, the F-18E/F Fighter Aircraft, the V-22 Osprey Tiltrotor Aircraft, the Comanche Scout Light Attack Helicopter, the Crusader Mobile Artillery Piece, the DD-21 Destroyer, and the Virginia-Class Submarine.

C. RESEARCH QUESTIONS

The primary research questions for this thesis are:

- In systems acquisition management, is it realistic to skip a generation of weapon system technology?

- How will the Department of Defense and the defense industrial base be impacted if weapon systems currently in development are skipped?

In order to obtain the basic knowledge necessary to develop and define the primary research questions, it was necessary to first answer the following subsidiary questions:

- What does "skip a generation of technology" mean?
- How does the Department of Defense develop new technology into a weapon system?
- How does DoD determine when technology is mature?
- How long is a generation of weapon system technology?

D. RESEARCH METHODOLOGY

Initial research included a thorough literature review. This literature review consisted of an extensive review of books, magazine and newspaper articles, Internet resources, and other library information resources. A thorough search of DoD's current weapon systems inventory was done using the Internet in order to compare how long different types of weapon systems technology lasts. Follow on research consisted of interviews with acquisition professionals from several DoD services.

E. ORGANIZATION OF THE STUDY

This thesis is organized into the following chapters:

Chapter II: Background - This chapter contains an overview of the Department of Defense acquisition life-cycle process. The four acquisition life-cycle phases will be thoroughly discussed, including a detail discussion on

the System Development and Demonstration phase. This discussion will lead to a comparison of how long different weapon systems technologies last. Next, the President's "skip a generation of technology" proposal and some of the weapon systems that may be skipped will be discussed. Finally, the chapter will conclude with the opposing view to the President's proposal.

Chapter III: Research Objective and Methodology - This chapter discusses why the research questions were selected and provides insight into the role of new technology in DoD, the current state of the defense industry, and the importance of new technology and the defense industry to DoD. Finally, it explains the methods used for executing the research design and the interview questions are presented.

Chapter IV: Data Presentation and Analysis - This chapter presents and analyzes the data.

Chapter V: Conclusions and Recommendations - This chapter summarizes the results and presents the conclusions of the thesis. Possible areas for future research are also discussed.

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II. BACKGROUND

A. INTRODUCTION

This chapter first discusses the basic concepts of the Department of Defense (DoD) acquisition life-cycle process, with an emphasis on the four acquisition life-cycle phases. Of these four phases, the System Development and Demonstration phase is discussed in detail to determine how DoD develops mature technology into a weapon system. (It should be noted that the following discussion of the DoD acquisition life cycle process was accurate at the time this research was completed. However, in August of 2002, the Deputy Secretary of Defense effectively cancelled the DoD governing instructions. Revisions to the process were unpublished at the time of this publication.) This discussion leads to a comparison of how long different types of weapon systems technologies last. After the life span's for different types of weapon systems technologies are defined, the chapter focuses on the President's "skip a generation of technology" proposal and a discussion of some of the weapon systems that may be skipped.

B. THE DOD ACQUISITION LIFE CYCLE PROCESS

The DoD acquisition life cycle process is a product of Federal policy and public laws. "The development, acquisition, and operation of military systems is governed by a multitude of public laws, formal DoD directives, instructions and manuals, numerous Service and Component regulations, and many inter-service and international agreements (Systems Engineering Fundamentals, 2001, p.

11)." These policies and laws focus the process on three basic activities critical to managing the development and fielding of military weapon systems: technical management, business management, and contract management. The acquisition process parallels the requirements generation process, which comes from the user and tends to be event driven. It also parallels the Planning, Programming, and Budgeting System (PPBS), which is date driven and subject to the constraints of the Congressional calendar (Systems Engineering Fundamentals, 2001, p. 11).

The Planning, Programming, and Budgeting System translates national security interests, developed by strategic planners, into military requirements. The military requirements then become budgetary requirements, which the United States Congress considers for funding. "The PPBS process operates on a continuous basis; each of the three functions of the system (planning, programming and budgeting) operates on a near-continuous basis, although not simultaneously on the same fiscal year. The process moves from *broad planning* considerations to more definitive program objectives to *specific budget estimates* that price out the programs (Financial Management, 2002)."

DoD uses the acquisition life cycle process to develop and field new weapon systems as fast as possible within acceptable technical risks. Acquisition, as defined by the Introduction To Defense Acquisition Management (IDAM), includes design, engineering, test and evaluation, production, and operations and support of DoD systems (IDAM, 2001, p. 1). The term "Defense acquisition" generally applies only to weapons and information

technology systems processes, procedures, and end products. The acquisition process itself is "defined by a series of phases during which technology is defined and matured into viable concepts, which are subsequently developed and readied for production, after which the systems produced are supported in the field (Systems Engineering Fundamentals, 2001, p. 12)."

The process is broken into a series of four phases of development, each phase assessing the maturity of the technology in development. Within each phase there are two work efforts, separated by milestone decision points, decision reviews, or interim decision reviews. These decision points and reviews provide both the program manager and Milestone Decision Authorities (MDA) the framework with which to review acquisition programs, monitor and administer progress, identify problems, and make corrections (IDAM, 2001, p. 54). Figure 1, taken from DoDI 5000.2, illustrates the acquisition process, its four phases, and milestone decision reviews.

The acquisition process has been revised several times in order to make it more flexible and allow the warfighter quicker delivery of advanced technology. The process encourages the use of evolutionary methods to define and develop systems and tailors the acquisition and engineering management without altering the basic systems engineering process (Systems Engineering Fundamentals, 2001, p. 11).

1. Purpose

The acquisition life cycle process exists to ensure DoD uses the latest technology, programs, and product

support necessary to achieve the United States' national security goals and to support its armed forces (IDAM, 2001, p. 1). The aim and ultimate challenge of acquisition managers is to use the process to develop technology that meets today's operational requirements and meets the requirements of tomorrow and future forces. "The primary objective of Defense acquisition is to acquire quality products that satisfy user needs with measurable improvements to mission accomplishments and operational support, in a timely manner, and at a fair and reasonable price (DoDD 5000.1, 2000)."

THE 5000 MODEL

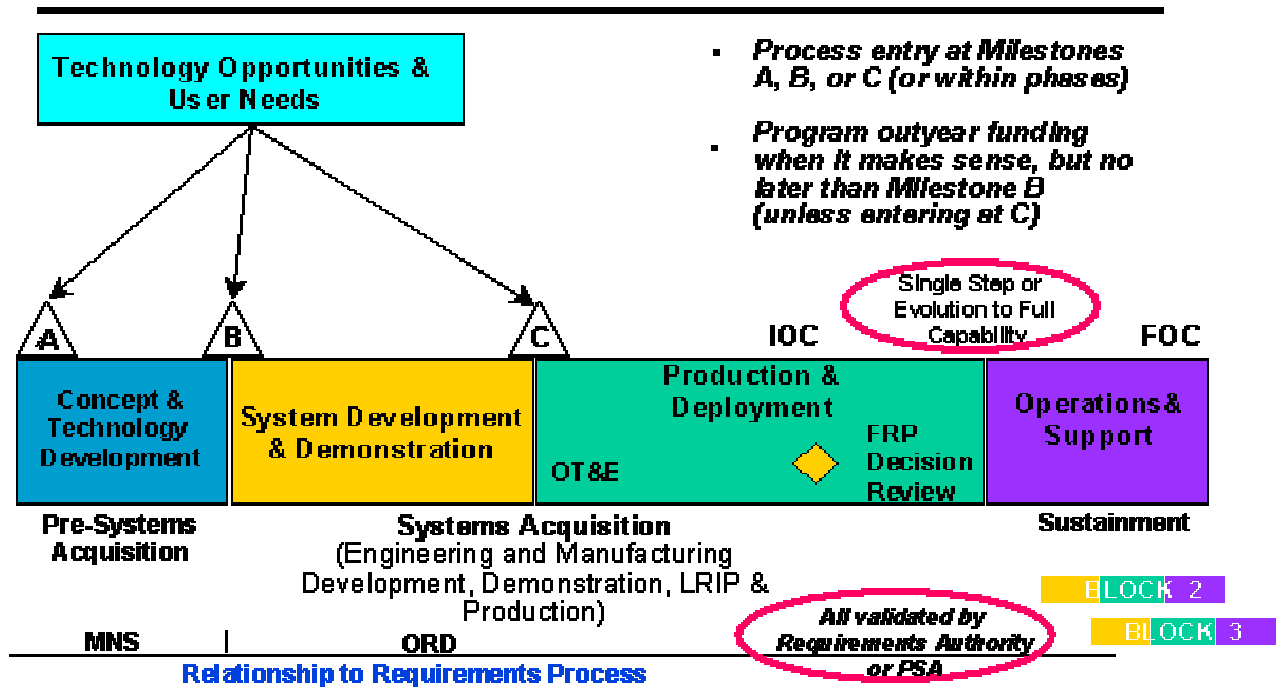


Figure 1. The DoD Acquisition Process. (From: DoDI 5000.2, 2001)

The DoDD 5000.1 *The Defense Acquisition System*, DoDI 5000.2 *Operation of the Defense Acquisition System*, and the

Introduction To Defense Acquisition Management are some of the documents that govern the acquisition process. These documents outline actions required of acquisition managers developing new weapon systems in order to meet national security and DoD goals. They focus on performance and results-based management to ensure the acquisition of efficient and effective weapon systems. The three main areas that these DoD directives and documents help focus acquisition managers on during product development are:

- Translating operational needs into stable, affordable programs
- Acquiring quality products
- Organizing for efficiency and effectiveness (Systems Engineering Fundamentals, 2001, p. 11)

2. Acquisition Life Cycle's Four Phases

DoD begins the acquisition process after determining the existence of a valid need from the warfighter. This includes the study and analysis of mission areas, a mission need analysis to determine if a non-materiel solution is best, an assessment of alternative solutions to meet war fighting deficiencies, and the development of system specific performance requirements (IDAM, 2001, p. 45). After determining that the warfighter's need cannot be satisfied through existing Federal Government or commercial industry products, a Mission Need Statement (MNS) is drafted to describe the warfighter's deficiency or technological opportunity.

From the MNS, the acquisition life cycle begins with the Concept and Technology Development phase, the first of the four phases. Following the Concept and Technology Development phase is the Systems Development and

Demonstration phase, the Production and Deployment phase, and finally the Sustainment and Disposal phase.

The acquisition life cycle process allows for a given weapon system under development to enter the process at any of the development phases. "For example, a system using unproven technology would enter at the beginning stages of the process and would proceed through a lengthy period of technology maturation, while a system based on mature and proven technologies might enter directly into engineering development or, conceivably, even production (Systems Engineering Fundamentals, 2001, p. 12)."

The Concept and Technology Development (C&TD) phase is intended to explore alternative concepts based on assessments of operational needs, technology readiness, risk and affordability. Entry into this phase does not mean DoD has committed to the new weapon system program, rather, it is the beginning of the acquisition process to determine whether or not a need (typically described in an MNS) can be met at reasonable levels of technical risk and at affordable costs. The decision to enter into the C&TD phase is made formally at the Milestone A review. This phase, along with the other three phases are discussed in more detail in the sections that follow.

The key to the acquisition process is that programs have the flexibility to enter at any of the first three phases. The decision as to where the program should enter the process is primarily a function of user needs and technology maturity. The MDA makes the decision for which phase a program starts in (Systems Engineering Fundamentals, 2001, p. 13). Using the acquisition life

cycle process, integrated product teams and other acquisition reform initiatives, program managers work with potential users, contractors and developers to develop acquisition strategies that allow delivery of capable, appropriate weapon systems on time, on budget, and with the performance parameters required of the user and the evolving DoD needs.

a. Concept and Technology Development

The Concept and Technology Development phase begins with a validated and approved Mission Need Statement. From the MNS, the user or user representative develops an initial Operational Requirements Document (ORD). Furthermore, the program manager formulates the program's initial acquisition strategy, cost estimates, acquisition program baseline, and test and evaluation master plan (IDAM, 2001, p. 56).

The primary purpose of this phase is to study concepts, to define alternative concepts and to provide information about the potential weapon system's capabilities and risks. The MDA holds a decision review to determine if key technologies are sufficiently mature to enter development in the next phase or if further advanced component development is necessary. If the key technologies involved are reasonably mature and have already been demonstrated, the MDA may agree to allow the system to proceed into program initiation; if not, the system may be directed into a Component Advanced Development stage (Systems Engineering Fundamentals, 2001, p. 12).

During the Component Advanced Development stage, a concept that demonstrates a needed capability (but the system architecture is not yet complete or the key technologies are not yet mature), can enter this stage to allow the architecture and technologies to develop. Once the concept is demonstrated in a relevant environment, and DoD understands and accepts the technical and cost risks, the C&TD phase ends and the exit criteria for the System Development and Demonstration phase are established. The products of this phase are, "a defined system architecture supported by technologies that are at acceptable levels of maturity" to allow the concept to enter into acquisition (Systems Engineering Fundamentals, 2001, p. 13).

b. System Development and Demonstration

Program initiation for DoD acquisition programs depends on three things: a valid requirement (found in the ORD), maturity of technology, and funding. These three things are needed before a Milestone B decision and formal systems acquisition begins. The successful passage of a Milestone B decision is then followed by the System Development and Demonstration (SD&D) phase (IDAM, 2001, p. 58). Entry into this phase may come directly as a result of a technological opportunity and urgent user need, as well as having come through concept and technology development.

This phase has two stages of development, System Integration and System Demonstration. The system program could enter either stage, depending on the technical maturity level, or the stages could be combined. A program

that has existing system architectures, but does not have component subsystems integrated into a complete system enters the System Integration stage. Before entering the Systems Demonstration stage, the program goes through an Interim Progress Review to confirm that the program is progressing as planned within the phase, or to adjust the program plan to better accommodate progress to date or changed circumstances (IDAM, 2001, p. 59).

The System Demonstration stage begins when subsystems have been integrated, prototypes demonstrated, and risks are considered acceptable, followed by an interim review by the MDA to ensure readiness. This stage's purpose is to demonstrate that the weapon system has operational utility consistent with the operational requirements. Engineering demonstration models are developed and system level development testing and operational assessments are performed to ensure that the system performs as required. The models are considered to be "advanced" or "fieldable" prototypes of the final system and the demonstrations are to be conducted in the system's intended operational environment (Systems Engineering Fundamentals, 2001, p. 13).

This phase ends once a system has been demonstrated in an operationally relevant environment and the exit criteria for the next phase, the Production and Deployment phase, are established. The product of this phase is an integrated and tested prototype that is ready for initial production. The SD&D phase will be discussed in more detail later in this chapter.

c. Production and Deployment

Following a successful Milestone C review, a program enters the Production and Deployment (P&D) phase when it demonstrates technical maturity in a relevant environment with no significant manufacturing risk. Also, the program must have an approved ORD, acceptable interoperability and operational supportability, compliance with DoD's Strategic Plan, and have demonstrated affordability and funding (IDAM, 2001, p. 60).

This phase consists of two states, Low Rate Initial Production (LRIP) and Full-Rate Production and Deployment. During the LRIP stage, enough production systems are produced in order to perform the initial operational test and evaluation, live fire testing, and operational test and evaluation. For Acquisition Categories (ACAT) I, programs with more than \$365 million for Research, Development, Test and Evaluation (RDT&E) and \$2.19 billion for Procurement in fiscal year 2000 dollars, and ACAT II programs, programs with more than \$140 million for RDT&E and \$645 million for Procurement, LRIP is limited to ten percent of the total production quantity. Non-major programs are determined by the MDA using the ACAT I and II limit as guidance (IDAM, 2001, p. 60). Upon completion of the LRIP stage, the system undergoes a Full-Rate Production Decision Review that authorizes the system to proceed to the Full-Rate Production and Deployment stage.

During the Full-Rate Production and Deployment stage, the weapon system is produced and fielded to the user. Here, the program manager insures that the systems are produced at an economical rate and deployed in

accordance with the user's requirements. Follow-on operational test and evaluation may also be conducted to confirm operational effectiveness and suitability, and/or verify the correction of deficiencies. As the system is produced and deployed, the Sustainment and Disposal phase begins.

d. Sustainment and Disposal

The last, and longest, phase is the Sustainment and Disposal (S&D) phase of the program. This phase focuses on all elements of logistics support (for example supply, maintenance, training, technical data, and support equipment) and operational readiness. This focus is necessary to maintain and sustain the deployed system in the most cost-effective manner possible (Systems Engineering Fundamentals, 2001, p. 13).

The system's life cycle support may include a shift from the contractor to the Government activity, or a combination of the two during post-production transition. To continue to be relevant to the user, modifications and product improvements are implemented as necessary to update and maintain the required levels of operational capability as technologies and threat systems evolve (Systems Engineering Fundamentals, 2001, p. 13). Also service life extension programs may be considered if the system continues to be pertinent beyond its intended life span.

At the end of the system's useful life, it is disposed of in accordance with applicable laws, regulations, and directives. In addition to demilitarization of the system, disposal activities also

include recycling, material recovery, salvage or reutilization, and disposal of by-products from development and production (IDAM, 2001, p. 62).

C. HOW DOD DEVELOPS TECHNOLOGY INTO A WEAPON SYSTEM

Developing mature technology is one of the most important areas in the DoD acquisition process. New technology enhances DoD's ability to fight and win wars. Therefore, assessing when the technology is mature enough for production is important to keeping costs under control and getting the technology to the user at the right time. Using technology readiness assessments and the System Development and Demonstration phase, DoD assesses technological maturity and develops it into a weapon system.

1. Assessing When Weapon System Technology Is Mature

As previously discussed, the Milestone Decision Authority determines when potential weapon systems technologies are sufficiently mature during the Concept and Technology Development phase. This decision is based on whether or not the technology has been demonstrated in the relevant environment and its supporting system architecture has been developed. The MDAs use technology assessments from DoD Component Science and Technology (S&T) Executives to assist them in their decisions.

The DoD 5000.2-R, *Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information System Acquisition Programs*, gives guidance for

technology maturity assessments. The DoD 5000.2-R says that:

[t]echnology maturity shall measure the degree to which proposed critical technologies meet program objectives. Technology maturity is a principal element of program risk. A technology readiness assessment shall examine program concepts, technology requirements, and demonstrated technology capabilities to determine technological maturity.

The [program manager] shall identify critical technologies via the work breakdown structure. Technology readiness assessments for critical technologies shall occur sufficiently prior to milestone decision points B and C to provide useful technology maturity information to the acquisition review process (DoD 5000.2-R, 2002 p. 113).

The S&T Executive for each service component is charged with directing the technology readiness assessments. For major acquisition programs, ACAT I programs, he or she uses a technology readiness level (TRL) to assess each critical technology in development. Using a numerical value from one to nine, "TRLs enable consistent, uniform, discussions of technical maturity, across different types of technologies...[and] are a measure of technical maturity (DoD 5000.2-R, 2002, p. 113)." Level one, (Basic principles observed and reported), is the lowest level and, likewise, level nine, (Actual system proven through successful mission operations), is the highest assessment of technology in its final form. "TRLs do not discuss the probability of occurrence (i.e., the likelihood of attaining required maturity) or the impact of

not achieving technology maturity (DoD 5000.2-R, 2002, p. 113)." A complete table of the nine TRLs and a brief description can be found in Appendix A.

S&T Executives are required to submit the technology assessments to the Component (Service) Acquisition Executive who then forwards them to the Deputy Undersecretary of Defense for Science and Technology (DUSD(S&T)). The DUSD(S&T) either concurs with the S&T Executive assessment or does not concur and directs an independent technology readiness assessment (DoD 5000.2-R, 2002, p. 113). DUSD(S&T) assessments are then forwarded to the MDA for final decision.

The MDA uses these assessments to determine if the technology is ready to exit the C&TD phase or if it needs further research and development. Also, if the technology receives a high TRL, the MDA will determine if the system enters the acquisition process at Milestone B or goes directly to Milestone C, the start of the Production and Deployment phase.

2. System Development and Demonstration Phase

The System Development and Demonstration phase begins after the program successfully passes a Milestone B decision. From here, the Department of Defense or (Service Component) commits to the program, provided that the program has proven that the technology can be developed and has validated requirements and funding. This phase consists of two primary stages, System Integration stage, followed by an Interim Progress Review, and the Systems Demonstration stage.

a. *The Purpose*

The DoDI 5000.2, *Operation of the Defense Acquisition System*, describes the purpose of this phase as:

The purpose of the System Development and Demonstration phase is to develop a system, reduce program risk, ensure operational supportability, design for producibility, ensure affordability, ensure protection of Critical Program Information, and demonstrate system integration, interoperability, and utility. Discovery and development are aided by the use of simulation-based acquisition and test and evaluation and guided by a system acquisition strategy and test and evaluation master plan (TEMP). System modeling, simulation, test, and evaluation activities shall be integrated into an efficient continuum planned and executed by a test and evaluation integrated product team (DoDI 5000.2, 2001).

As previously stated, entry into this phase may come directly as a result of a technological opportunity and urgent user need, as well as having come through concept and technology development. The Milestone Decision Authority determines the entry point, which is Milestone B, based on the maturity of the technologies, validated requirements (including urgency of need), and affordability (DoDI 5000.2, 2001).

b. *Entrance Criteria*

The Concept and Technology Development phase studies concepts, defines alternative concepts and provides information about capability and risk of the potential weapon system to be developed. Before the SD&D phase

begins, a decision review determines whether further technology development is required, or whether the system is ready to enter into systems acquisition. The result of this review will determine if the program meets the three critical entrance criteria for the SD&D phase: technology maturity, validated requirements, and funding.

DoDI 5000.2 states, "[u]nless some other factor is overriding in its impact, the maturity of the technology will determine the path to be followed (DoDI 5000.2, 2001)." Therefore, of these three entrance criteria, technology will be the biggest determining factor as to where the program enters this phase. The program's technology maturity, either developed within DoD laboratories and research centers or procured from industry, is assessed by a demonstration within the relevant or operational environment the systems is to be operating in. A successful demonstration means the technology is mature enough to use for product development in systems integration.

If technology is not mature, the program will be allowed to proceed provided a mature, alternative technology can meet the user's needs (DoDI 5000.2, 2001). The Service Component Science and Technology (S&T) Executive determines technology maturity. However, the DUSD(S&T) reviews the service component's decision for major acquisition programs, and if he/she does not concur with the determination, the DUSD(S&T) will direct an independent assessment before the program enters this phase.

The second critical entrance criterion is validated requirements in the Operational Requirements Document. The ORD contains operational performance requirements and addresses the program's future costs. The requirements authority, prior to program approval, must validate the ORD (DoDI 5000.2, 2001). For major program acquisitions, the requirements authority is the Vice-Chairman of the Joint Chiefs of Staff, filling the role as Chairman of the Joint Requirements Oversight Council.

The third of the three critical entrance criteria is funding. The DoDI 5000.2 states that the determination on whether or not the program is affordable "is made in the process of addressing cost as a military requirement in the requirements process and included in each ORD, beginning with the acquisition cost but using life-cycle cost or total ownership cost where available and approved (DoDI 5000.2, 2001)." Entry into the SD&D phase requires full funding after the system concept and the program's design has been selected. Furthermore, it is at this point that the program manager is assigned.

c. Milestone B

Milestone B is normally the official beginning or initiation of an acquisition program. Whether or not a program is initiated depends on the three critical entrance criteria previously mentioned. The MDA confirms that technology maturity, valid requirements, and funding have been established before the program initiation decision is made. "On rare occasions, program initiation may be appropriate earlier than Milestone B. If so, program

initiation will take place upon entry into, or during, Component Advanced Development (IDAM, 2001, p. 58)." The purpose of the Milestone B decision is to authorize entry into the SD&D phase and there will only be one Milestone B decision per program.

d. Systems Integration

As Figure 2 shows, the Systems Integration stage has two main purposes. These are systems integration of demonstrated subsystems and components and the reduction of integration risk. For a new system not previously developed, this stage will continue to build on the work begun in the Concept and Technology Development phase, but focus of effort shifts towards engineering development, rather than the research-oriented efforts (Systems Engineering Fundamentals, 2001, p. 17).

A weapons system program enters this stage when "a system architecture exists, but the component subsystems have not yet been integrated into a complete system (IDAM, 2001, p. 59)." The focus is on integrating the subsystem components so that the system prototype can be tested in a relevant environment. The integration risks that need to be reduced are the "misunderstandings and errors regarding system-level requirements [that] will flow down to subsequent designs and [will] eventually result in overruns and even program failure (Systems Engineering Fundamentals, 2001, p. 18)." Therefore, a thorough requirements analysis and review must be done to ensure that the user, the contractor, and program office all hold a common view of the requirements.

System Development and Demonstration Work Content

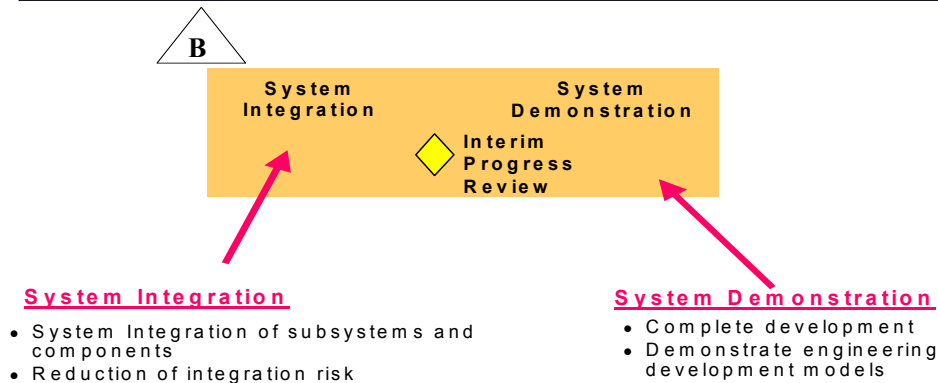


Figure 2. The System Development and Demonstration Phase. (From: DoDI 5000.2, 2001)

The System Integration stage is finished when the integration of the system has been "demonstrated in a relevant environment using prototypes (e.g., first fight, interoperable data flow across systems), a system configuration has been documented, the MDA determines a factor other than technology justifies forward progress, or the MDA decides to end this effort (DoDI 5000.2, 2001)." This stage is followed by an Interim Progress Review, which will decide whether or not the program continues to the System Development stage.

e. Interim Progress Review

The Introduction To Defense Acquisition Management describes the purpose of the Interim Progress Review as a confirmation "that the program is progressing as planned within the System Development and Demonstration phase or to adjust the program plan to better accommodate

progress to date or change circumstances (IDAM, 2001, p. 59)." The Milestone Decision Authority must approve adjustments to the acquisition strategy. There is no established agenda during this review because it is designed to be flexible so that the information specifically requested by the MDA is provided.

f. System Demonstration

The Systems Demonstration stage has two main purposes: complete development and demonstrate engineering development models. It is during this phase that the engineering models are demonstrated to show they can function consistently in accordance with the requirements in the ORD. These engineering prototypes are not production representative systems instead, "they are system demonstration models, or integrated commercial items, that serve the purpose of enabling the developer to accomplish development testing on the integrated system (Systems Engineering Fundamentals, 2001, p. 18)." Critical system elements, like flight controls and avionics subsystems for an aircraft, may be tested separately to show that the subsystem integration is complete and to accomplish the developmental testing.

The System Demonstration stage and System Development and Demonstration phase ends when "a system is demonstrated in its intended environment, using engineering development models or integrated commercial items; meets validated requirements; industrial capabilities are reasonably available; and the system meets or exceeds exit criteria and Milestone C entrance requirements (DoDI

5000.2, 2001)." The MDA decides to continue with the program at Milestone C or decides that the program should be discontinued. Conclusion of the SD&D phase means the system is ready to begin its low-rate initial production.

D. HOW LONG DOES WEAPON SYSTEM TECHNOLOGY LAST?

It is important to define how long different types of weapon system technology last before an analysis of President Bush's proposal can be made. To do this, a sampling of a few weapon systems from ships, aircraft, ground combat vehicles, artillery and other categories was used to get a rough idea. All the information was gathered using the Internet search engine periscope.ucg.com under the weapons/systems/platforms category unless otherwise noted in Appendix B. Appendix B gives a breakdown of each type of weapon system category and brief remarks. The averages do not represent the exact weapon system's technology life span, but are used to roughly define a generation of technology.

1. Ships

Twenty-two different types of ships from four different categories were analyzed including: Aircraft Carrier, Amphibious, Frigate/Cruiser/Destroyer, and Submarine. The commissioning date of the first ship in class was used to define the beginning for the class' service life period as opposed to the service life of a single platform. Likewise, the decommissioning date of the last ship defines the ending for the service life period of the class. The three classes of Aircraft Carriers analyzed

had an average of 50.0 years of service. In the Amphibious category, three classes were also analyzed with an average of 38.7 years of service. In the Frigate/Cruiser/Destroyer category, nine ships - two frigates, four cruisers, and three destroyers - had an average service life of 29.3 years. Finally, seven submarine classes were analyzed and determined to have an average of 28 years of service. The combination of all 22 different ship classes had an average 36.5 years of DoD service.

2. Aircraft

Twenty different types of aircraft were analyzed from three different classes which include: Attack/Fighter, Large Fixed Wing and Helicopter. The Initial Operational Capability (IOC) date was used to define the weapon system's beginning and the retirement date or projected retirement date was used to define the ending. An aircraft type within the class may have been upgraded several times and may not reflect the original aircraft. However, this analysis does not distinguish between the upgrades to determine a new generation. Rather, the entire life span of the aircraft designation is considered one generation. For example, the AH-1G introduced in 1967 for the Marine Corps is much different in looks, equipment and capabilities than the AH-1Z that will be introduced in 2005. The entire life span of the AH-1 is considered one generation. This method was used consistently for the other weapon system categories.

The eight Attack/Fighter aircraft analyzed had an average of 29.5 years of service. The Large Fixed Wing

aircraft - which include a bomber, five cargo/transport and an anti-submarine aircraft - have an average of 58.9 years of service. Finally, the five helicopters analyzed have an average of 56.4 years of service. The types of aircraft chosen are used by the Army, Navy, Air Force and Marine Corps and have a combined average of 48.3 years of DoD service.

3. Ground Combat Vehicles

A sample of eight different ground combat vehicles from air defense, armored personnel carrier, amphibious assault vehicle, and tank classes were used. Similar to the aircraft previously described, the IOC date was used to define the weapon system's beginning and the retirement date, or the projected retirement date was used to define the ending. The eight vehicles had an average of 36 years of service. The M163 Vulcan; Light Armored Vehicle-150 Commando Series (4x4); M113 Armored Personnel Carrier; Amphibious Assault Vehicle-7; Landing Vehicle, Tracked, Personnel-5; M88 Armored Recovery Vehicle; the M1 Abrams tank; and the M60 Patton tank were the vehicles chosen.

4. Artillery

Four artillery pieces, one a towed version and three self-propelled versions, were analyzed. The IOC date and the retirement date were used to define the technology length. The average service life of these four pieces came to 33.3 years.

5. Others

Eight other weapon systems round out the analysis. This final section is made up of one anti-tank, two anti-radar, three anti-air missiles and two torpedoes. The length of technology for these projectiles was defined as beginning at IOC and ending with the retirement date. The retirement dates of the AGM-114 Hellfire, which is scheduled for upgrade, and the AIM-7 Sparrow, for which production ended in the 1990s, were estimated since no information was available. These two projectiles are still used on several platforms. The eight projectiles had an average service life of 38.5 years.

E. PRESIDENT BUSH'S PROPOSAL TO SKIP A GENERATION OF TECHNOLOGY

President George W. Bush's "skip a generation of technology" proposal focuses on transforming and reforming the DoD acquisition process. In his own words, Bush said of his proposal, "We will modernize some existing weapons and equipment, necessary for current tasks...to move beyond marginal improvements to replace existing programs with new technologies and strategies - to use this window of opportunity to skip a generation of technology (Hellman, 2000)." The four main areas of this proposal are increasing the pace of weapons system development; investing in newer, future technologies while modernizing existing equipment; transforming DoD to the changing threat and shrinking Defense budget; and skipping weapon systems currently in development that are no longer relevant.

1. Increasing the Pace of Weapon System Development

In order for the DoD to meet the emerging threats of the Twenty-first century, it must be able to develop weapon systems more quickly. DoD's acquisition process "has become slower, while the pace of technological change has become far more rapid" creating "a situation where it is difficult for the acquisition process to produce anything other than capabilities that are already a generation behind when deployed (Mann, 2001)." This goes to the heart of the proposal, which is determined to decrease the time it takes to get new weapon systems fielded.

One reason the procurement process is taking too long is that the bureaucratic and political regulation of the acquisition life cycle process has become overly burdensome. Gordon Adams, director of the security policy studies program for the Elliott School of International Affairs at George Washington University said the failure of the acquisition process to produce timely weapon systems is a "combination of bureaucratic rigidities in the acquisition system, an excess of bureaucratic intervention in the process of [weapons] development and partially budgetary limitations (Mann, 2001)." This bureaucracy has caused the nine-year acquisition process for major weapon system programs to draw out 15 to 20 years (Mann, 2001).

2. Investing In Newer, Future Technologies While Modernizing Existing Equipment

The second key part of the proposal is to invest in newer, future technologies while modernizing existing equipment. Modernizing existing weapon systems and equipment will facilitate skipping current weapon systems

in development and allow future technologies to be developed and fielded. President Bush said to an audience in Norfolk, Virginia that, "We will modernize some existing weapons and equipment, a task we have neglected for too long...[b]ut we will do this judiciously and selectively. Our goal is to move beyond marginal improvements to harness new technologies that will support a new strategy (Ruddy, 2001)."

In order to acquire weapon systems with the latest technology, President Bush has proposed significant increases in the RDT&E budget. The RDT&E budget fell from the Reagan Buildup Era high of \$51.375 billion (constant FY 2003) in 1987 to a low of \$39.024 billion (FY 2003) in 1995 (FY 2003 Defense Budget 2003, pp. 113, 114). DoD's budget has RDT&E increasing steadily over the next few years to \$58.429 billion (FY 2003) in 2005 (FY 2003 Defense Budget 2003, p. 115). Furthermore, Bush proposes spending 20% of the annual procurement budget (roughly \$13 billion) on advanced technology programs (Hellman, 2000). Weapon systems with newer technology will be characterized "not by mass or size but by mobility and swiftness (Hartung, 2002)," in order to meet the requirements of the new battlefield.

3. Transforming DoD to the Changing Threat and Shrinking Defense Budget

Shortly after the collapse of the Soviet Union, the Federal Government decreased spending on national defense. Likewise, the threat environment to the United States has changed in location, scale and form. Therefore, the third main purpose of the proposal is to transform DoD to meet

the changing threat environment with a reduced amount of national resources devoted to defense.

DoD's share of the Federal budget went from 27.3% of federal outlays in 1987 to 15.9% in 2002 and its percentage of gross domestic product has decreased from near 5.9% to less than 3.2% during the same period (FY 2003 Defense Budget 2003, p. 217). Though DoD's Federal budget share increases 1% in 2003, senior Pentagon leadership realizes that DoD cannot balance its budget and keep all the weapon systems in procurement. The Secretary of Defense, Donald Rumsfeld, acknowledged, "the Pentagon cannot pay for all of the programs now on the books (Shanker and Doa, 2002)," and has proposed billions of dollars in weapons cuts.

Meanwhile, as the budget continues to shrink relative to the needs, the threat environment is changing. Some experts argue that today's military is not suited for dealing with tomorrow's defense challenges. New missions such as defeating anti-access/area-denial threats, controlling space and homeland defense requires major changes in U.S. military doctrine, force structures, capabilities, and investment patterns, and consequently a more flexible, relevant acquisition process (Krepinevich, 2001).

4. Skipping Weapon Systems Currently In Development that Are No Longer Relevant

The fourth area of President Bush's proposal is to skip weapon systems currently in development, designed to fight in the Cold War Era, which are no longer relevant. During one of his speeches, the President stressed "the

need to move beyond a military force 'organized for Cold War threats' in which there is 'almost no relationship between our budget priorities and a strategic vision (Hartung, 2002).'

Continuing the President's call for military transformation, Defense Secretary Rumsfeld "vowed to cancel obsolete systems, cut entrenched force structure, and forge a quicker, smarter, more mobile force to meet the threats of the future (Borosage, 2002)."

Weapon systems currently under development that may be skipped span all DoD Services as the focus shifts "away from Cold War remnants of heavy artillery and aircraft carriers (Daniel, 2001)." These systems include the F-22 Tactical Fighter Aircraft, the F-18E/F Fighter Aircraft, the V-22 Osprey Tiltrotor Aircraft, the Comanche Scout Light Attack Helicopter and the Virginia-Class Submarine. The Crusader Mobile Artillery Piece and the DD-21 Destroyer programs are restructuring due to recent DoD actions. These weapon systems will be described in greater detail in the sections that follow.

a. F-22 Tactical Fighter Aircraft

The F-22 Raptor Advanced Tactical Fighter aircraft, produced by Lockheed Martin Corporation, is the future air superiority fighter for the U.S. Air Force. Designed to be stealthy, the F-22 is the most advanced aerial combat plane ever produced. "The aircraft was originally designed during the Cold War to counter a sophisticated future threat from Soviet fighter planes that never came to fruition (Eland, 2001)," and the price of \$180 million per copy makes it the most expensive. The

Raptor began the acquisition process in 1983 when a concept definition study award was issued to six aerospace contractors. Despite nearly two decades in the acquisition pipeline, the program is only now undergoing LRIP (Jane's/F-22, 2002).

Critics argue that the F-22 is a prime candidate to be skipped because the United States has established air superiority with aircraft currently in its inventory. Moreover, on May 10, 2002 senior Pentagon officials "ordered the Air Force to study several alternatives that could replace existing plans to buy 295 F-22 Raptors" and "look at specific options involving fewer aircraft, as well as alternatives for accomplishing the air-superiority mission in other ways (Crawley and Maze, 2002)." The Joint Strike Fighter (JSF) may be a suitable substitute and can be produced more cost effectively by the Air Force than the F-22.

b. F-18E/F Fighter Aircraft

The F-18E/F Super Hornet is an upgraded version of F-18C/D tactical aircraft carrier based fighter for the U.S. Navy and Marine Corps. The E/F variant is designed to overcome the limited range of the C/D and incorporate the latest in aerospace technology. The Boeing Company is the prime contractor and the program is currently in full rate production at a cost of about \$59 million per aircraft (Jane's/F-18E/F, 2002).

The F-18E/F is a good candidate because President Bush has expressed skepticism about buying three new tactical fighters in the past. He believes that the

country cannot afford to field the F-22, F-18E/F and the JSF, which combined, will cost \$380 billion. He said we should "pick the best one, and the one that fits into our strategy (Eland, 2001)." One of the program's biggest critics has been the U.S. General Accounting Office (GAO). GAO has criticized its program management and has been skeptical about whether its "design represents a sufficient improvement in capability to be worth the cost of procuring (Periscope/F/A-18E/F, 1999)." Savings from the F-22 and F-18E/F program could be used to fund other DoD priorities.

c. V-22 Osprey Tiltrotor Aircraft

The V-22 weapon system is a multi-engine; dual-piloted, self-deployable, medium lift, vertical takeoff and landing aircraft that will perform future U.S. Marine Corps, U.S. Navy and U.S. Special Operations Command combat missions (Whitworth, 1996, p. 23). Developed by both Bell Helicopter Textron and Boeing, the V-22 combines the agility of a helicopter and the speed and extended range of an airplane. Operating like a helicopter for takeoffs and landings, the V-22, once airborne, converts to a turboprop aircraft capable of carrying up to twenty-four combat-equipped soldiers for 2,100 nautical miles after a single in-air refueling (Inspector General Report, 2000, p. 1). The V-22 is intended to replace the Marine Corps aging CH-46E and CH-53D fleet and become its main assault aircraft. Each Marine Corps version per unit cost is \$57 million in FY2000 dollars. The program is currently in the system demonstration stage after two crashes have delayed sending the program to production (Jane's/V-22, 2002).

What make the V-22 a prime candidate to be skipped are its poor safety, reliability and maintainability record and its high cost. Several times as costly as other substitute helicopters, the program "has already cost \$15 billion more than was initially estimated and is 10 years behind schedule (Eland, 2001)." In April 1989, then Secretary of Defense Richard Cheney - who ironically is now the Vice President - canceled the V-22 program citing a lack of affordability although Congress overturned that decision. Therefore, critics argue that the V-22 will likely be skipped and the program's funding diverted to acquire cheaper CH-53 or H-60 helicopters.

d. Comanche Scout Light Attack Helicopter

The Army's RAH-66 Comanche helicopter is the first combat helicopter designed from the outset to have "stealth" features and target acquisition features (Jane's/RAH-66, 2001). At a cost of about \$33 million each, the Comanche was originally designed "to hunt Soviet tanks on the central plains of Europe (Eland, 2001)," a mission that is out-of-date. Like the F-22 and the V-22, the Comanche has had its trouble in the acquisition pipeline. Currently the program is in the system demonstration stage and is expected to go to LRIP in October 2004 (Jane's/RAH-66, 2001).

As the mission statement for the Comanche is rewritten and the Army undergoes its transformation, cancellation of the Comanche may be necessary to free up funding. "As late as April of 1998, the U.S. Army's RAH-66 Comanche armed reconnaissance helicopter program was on

track, but defense officials stated that the program faced an equal chance of either being accelerated or never reaching production (Periscope/RAH-66, 2000)." A light attack version of the OH-58 Kiowa helicopter might be a less expensive Army alternative if the program is skipped.

e. *Crusader Mobile Artillery Piece*

The Crusader is an advanced field artillery system with a self-propelled 155 mm howitzer currently in the system demonstration stage. United Defense is developing the Crusader to replace the Army's current M109-series Paladin 155 mm self-propelled howitzer, whose basic design is over 40 years old (Jane's/Crusader, 2002). Each Crusader costs about \$23 million per weapon system (Eland, 2001).

The Army is currently undergoing a transformation that is supposed to make it lighter. That is why the "fully loaded system [that] could still weigh 80 tons (with its supply vehicle) (Eland, 2001)" makes a good candidate to be skipped. In fact, on May 8, 2002, Defense Secretary Rumsfeld announced his decision to ask Congress to terminate funding for the Crusader, a system which he feels the Army and DoD cannot afford (Crawley and Maze, 2002). Other options for the Crusader include investing in R&D for a lighter mobile artillery piece and upgrading the existing mobile artillery piece, the Paladin, with a larger tube (Eland, 2001).

f. DD-21 Destroyer

The DD-21, now called the DD(X) program, is a future destroyer that is being developed to attack land targets. The DD-21 was supposed to have 120 vertical launch system cells to launch land attack missiles and two 155 mm guns to fire guided rocket-assisted shells. The new DD(X) will likely have the same capabilities but will have a "common hull form and technology development (Jane's/DD(X), 2001)" that will be used in combination with the future cruisers (CG(X)). Now that the program has been renamed DD(X), a new request for proposal has been issued, starting the Concept and Technology Development phase over. The DD-21 ships were going to cost \$780 million each and future destroyer prices are likely to be higher (Eland, 2001).

Like the other programs on this list, cost is the main reason the DD(X) program may get skipped. One of 70 major DoD programs experiencing cost increases, the DD(X) program's cost "rose from \$5.2 billion to \$10.8 billion, a 107 percent increase (Lowe and Brown, 2002)." In 2001, the House Appropriations Committee slashed the DD-21 budget by 75 percent and in 2000 DoD directed the Navy to slide its production schedule to accommodate the rising research and development cost estimates (Periscope/DD(X), 2002). Alternatives for the Navy include continuing to build and upgrade the existing DDG-51 destroyers.

g. Virginia-Class Submarine

Lastly, the Virginia-class submarine is the Navy's "New nuclear-powered Attack Submarine (NSSN)." The

program is a joint venture and is being developed by General Dynamics, Electric Boat Division and Newport News Shipbuilding and Drydock Company at \$2.2 billion each. A total of 30 Virginia-class submarines are scheduled to be produced at a rate of one ship per year (Eland, 2001). The new submarines will allow the Navy more flexibility and be capable of operating near the shore as part of the Navy's "From the Sea" strategy (Periscope/Virginia (SSN-774) class, 2002). After the fall of the Soviet Union, the need for large nuclear submarines has diminished prompting the Navy to adopt the Virginia Class platform over the larger, more capable Seawolf class.

Critics argue that production on the Virginia-Class Submarine can be terminated because the U.S. has subsurface superiority in its existing submarine fleet. "Even if Russia does build a few new boats and even if the Virginia-class is truncated, the United States will have the best submarine fleet in the world for the foreseeable future" and, "the three Seawolf-class submarines, the few Virginia-class boats already funded, and numerous 6881 Los Angeles-class ships cannot be matched by any nation, including Russia (Eland, 2001)." The GAO reported in 1998 that "an improved threat and cost-based reductions in certain systems' performance may mean that the nuclear subs are not as capable as needed" noting that "funding cuts within the program have reduced capabilities (Periscope/Virginia (SSN-774) class, 2002)." Therefore, President Bush may choose to cancel this program and shift its funding to other priorities like spy satellites, unmanned and manned reconnaissance aircraft and National Missile Defense.

F. OPPOSITION TO THE "SKIP A GENERATION" PROPOSAL

Not everyone agrees with the "skip a generation of technology" proposal. Dr. Jim Richardson, vice president for research at the Potomac Institute for Policy Studies, thinks the proposal is "flawed in its absolutism" and cautions the Administration to take "a reasonable approach to things and replace technology where it needs to be replaced (Ruddy, 2001)." The biggest opposition is likely to come, however, from Congress, the DoD Services, and contractors who are desperately trying to protect their programs and justify their necessity. They stress the potential negative impact that skipping weapon systems will have on DoD readiness. DoD is already saddled with aging systems and increasing operating costs.

1. Tough Sell to Congress and the Services

A challenge for the proposal will be to get both sides of ideological lines to agree to weapons cuts. Loeb and Graham agree, stating that the "inability to please either camp despite a proposed \$48 billion increase in military spending highlights the Pentagon's continuing difficulty in cutting impractical big-ticket programs (Loeb and Graham, 2002)." This stalemate makes any attempt at skipping a weapon platform a difficult task. Likewise, Congressmen within districts that will be affected by cuts, services badly needing replacement systems, and the contractors "are expected to put up fierce resistance in the months before writing the 2004 budget and appropriating the funds (Shanker and Dao, 2002)".

A good illustration of a Congressional fight over canceling a weapon system is the V-22 Osprey. The V-22 Osprey, which has been in development since it was a U.S. Army program in 1982, has yet to reach full rate production (Jane's/V-22, 2002). The aircraft is slated as the replacement for the Marine Corps' "aging fleet of slower and louder Vietnam-era [CH-46E and CH-53D] helicopters (Associated Press, 2002)". Both the CH-46E and the CH-53D are beyond their intended service life. Despite the V-22's development problems, both the Marine Corps and Congress have continued to support the aircraft. One supporter in Congress includes Representative Curt Weldon (Republican, Pennsylvania), the chairman of the House Armed Service Research and Development Subcommittee, who has "launched an aggressive campaign to keep the Osprey program alive (Kitfield, 2001)." Boeing Helicopters, co-developer of the Osprey, is located in Pennsylvania.

2. Aging Equipment and Increasing Operating Costs

The effects of aging equipment and a decreasing defense budget early in the 1990's weren't at first apparent because much of the Reagan Buildup Era equipment was still fairly new and the cost to operate and maintain such equipment was low. But, as the decreasing-funding trend continued, DoD was forced to shift procurement funding to operations and sustainment (O&S) pay to maintain these systems. "Critics argue that tight budgets in the 1990s have led the [Clinton] Administration to cut weapons modernization too deeply to protect near-term readiness. Low rates of modernization, they contend, will jeopardize the 'future readiness' of the force, which depends on

modern weaponry (Tryszkiewicz and Daggett, 1998).” The modernization cuts forced DoD to put off future procurement investments to pay to maintain the current systems. This downward cycle of robbing from the future has compounded the aging systems problem. Figure 3 illustrates this cycle.

These same critics point to aging weapon systems and the downward “death spiral” as the biggest reason DoD cannot afford to skip current weapon systems in development. “Industry officials argue that the Pentagon needs to buy weapons like the F-22 because existing equipment is rapidly wearing out, making it expensive to maintain. Waiting for new technologies to become available will cost the Pentagon more money in spare parts and maintenance (Shanker and Dao, 2002).” The F-22, like other major programs, has been in the acquisition cycle for 20 years and, skipping the F-22 means stretching current fighter aircraft until the next generation fighter is developed.

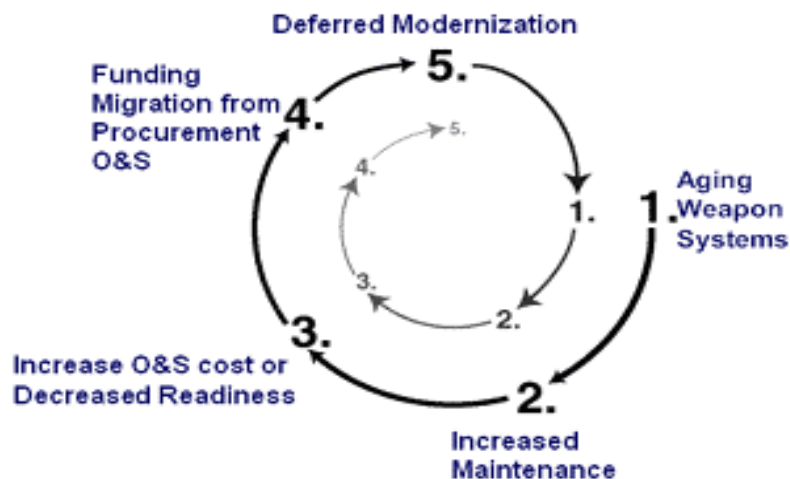


Figure 3. DoD's Death Spiral. (From: Louden, Undated, Slide 9)

G. SUMMARY

This chapter first described the Department of Defense acquisition life cycle process and its four phases. DoD uses the acquisition life cycle process to develop and field new weapon systems. The process focuses on performance and results-based management to ensure the acquisition of efficient and effective weapon systems. The life cycle process helps focus acquisition managers on translating operational needs into stable, affordable programs, acquiring quality products, and organizing for efficiency and effectiveness.

Second, how DoD assesses when weapon system technology is mature and how it develops the technology into a weapon system were discussed. The Milestone Decision Authority determines when potential weapon systems technologies are sufficiently mature during the Concept and Technology Development phase using a technology readiness level to assess each critical technology in development. The System Development and Demonstration phase integrates the technology into a prototype that is used to determine if the weapon system is ready for production.

Finally, the life spans for different types of weapon systems technology were defined. After defining a generation of technology, the President's proposal to skip a generation of technology was discussed. The four main areas of his proposal are increasing the pace of weapon system development; investing in newer, future technologies while modernizing existing equipment; transforming DoD to the changing threat and shrinking federal budget; and skipping weapon systems currently in development that are

no longer relevant. Next, five possible weapon systems that may be skipped and two that are restructuring were discussed. The chapter concluded with arguments for why some critics are opposed to the proposal.

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III. RESEARCH OBJECTIVE AND METHODOLOGY

A. INTRODUCTION

This chapter begins by discussing why the research questions were selected and provides insight into the role of new technology in the Department of Defense (DoD), the importance of the defense industry to national security, and how new technology and the defense industry relate to each other. Next, the data collection interview methodology is discussed and the data collection technique and interview questions are presented. Initial research included a thorough literary review of books, magazine and newspaper articles, Internet resources and other library information resources relating to the DoD acquisition life cycle process and President Bush's "skip a generation of technology" proposal. Follow-on research consisted of e-mail interviews. Interviews were conducted with a wide variety of DoD acquisition professionals.

B. OBJECTIVE

As it is apparent from Chapter II, while in theory it may be possible to skip weapon systems in development, the effects on acquisition management and the defense industry are uncertain. Both the defense industry and the Government make large investments of time, money, and resources when developing new technology for a weapon system. The documents that govern the acquisition process guide acquisition managers. Strict adherence to these guidelines is key to successful development of a weapon system. On the other hand, defense contractors'

investments in the technology and the weapon system often aren't recouped until after the system undergoes production. It is these expected returns of investments that keep the defense industry going.

Cancellation of a weapon system can be devastating to that company and ultimately that sector of the defense industry. For Example, in the mid 1990s Ratheon Company began acquiring military-electronics firms. These electronic firms could not convert their businesses to commercial applications after their defense programs were canceled. A report by the Defense Budget Project stated, "The cancellation or culmination of several existing or projected major-weapon systems has had, and will continue to exert, a profound effect on the defense industrial base (Coolidge, 1995)." Aggressive job cuts, plant closings, and these types of mergers were the result of the cancellations. Therefore, realizing the importance of the acquisition process and the defense industry to the development of new weapon systems, the objective of this thesis is to answer the following two primary research questions:

- In systems acquisition management, is it realistic to skip a generation of weapon system technology?
- How will the Department of Defense and the defense industrial base be impacted if weapon systems currently in development are skipped?

Prior to conducting research for this thesis, the initial objective was to compare and contrast the opinions of DoD acquisition professionals with those of defense contractors regarding the President's proposal. Unfortunately all of the defense contractors that were

contacted by the author declined to be interviewed. Therefore, the decision was made to restrict the focus of research to DoD acquisition professionals only.

The paragraphs that follow will focus specifically on the roles of new technology in DoD, the current state of the defense industry and the relationship of the defense industry to the Department of Defense.

1. The Role of New Technology in DoD

In 2000, the Pentagon released its future joint warfighting plan, Joint Vision 2020. Joint Vision 2020 highlights the role technology will play in future DoD forces as it is heavily focused on "the increasingly important role of command, control, communication, computers and intelligence (C4I) technologies in joint and coalition operations (Phillips Business Information Corporation, 2000)." Therefore, new technology will play and increasingly important role in current weapon systems and in the acquisition of new weapon systems. "[T]he Joint Vision 2020 report notes that not only must technology be embraced, but upgrading the procedures for integrating those technologies should also be a key focus for future acquisition authorities (Phillips Business Information Corporation, 2000)."

One DoD challenge to incorporating new technology into new and existing weapon systems is to overcome the funding deficiencies that have plagued the department throughout the 1990s. As its equipment continues to age and operational costs increase, developing and exploiting new technology is becoming increasingly more difficult. "As

the military works to transform itself into units that lend themselves to expeditionary operations, Congress and a number of uniformed leaders have said that there remains a gap between the level of funding allocated to current capabilities and base infrastructure and that provided for the development of new technologies (Keeter, 2001)."

Some critics argue that DoD's inability to capitalize on existing and future technologies and the outdated equipment it is using now are reasons why DoD cannot afford to skip over the systems in development. One defense official said "in some cases you get systems aging to the point where it's necessary to replace them with what you've got (Freedberg Jr., 2000)," and that failing to do so will put DoD even further behind in modernizing its forces.

Senior DoD officials and its supporters in Congress contend that new technology and weapon systems are crucial to keeping America's forces number one in the world. Perhaps Representative Curt Weldon (Republican, Pennsylvania) put it best when he said, "the development of new systems and technologies to suit tomorrow's battlefield requirements is also key to keeping the military on the cutting edge of combat capability (Keeter, 2001)."

2. The Current State of the U.S. Defense Industry

Since September 11, 2001, the U.S. defense industry has experienced its biggest boom since the 1980s. "U.S. arms procurement and research and development (R&D) budgets in 2002 have jumped to \$109 billion, a 5.4% increase from the previous year, which in turn has boosted Wall Street's valuation of defense companies' share prices and market

capitalization to robust levels (Jane's/US Defence Industry, 2002)." However, the defense industry is still trying to recover from the 1990s, a decade with the lowest percentage of gross domestic product spending on defense since World War II.

With the fall of the Soviet Union and at the end of the Cold War, deep cuts in defense spending have been the trend throughout the 1990s. As Mary Tryszkiewicz and Stephan Daggett indicate, "when the 'ups and downs' are smoothed out," our national defense budget authority declined in real terms "by about 3.4 percent per year from FY 1985 to FY 1998" and, "total budget authority for national defense declined by 36% in real terms between the peak of the Reagan Buildup Era in FY1985 and FY1998, while weapons procurement declined by 67% and O&S by just 17% over the same period (Tryszkiewicz and Daggett, 1998)."

The decline in overall defense funding, combined with the increased operational tempo during the decade, forced DoD to divert future weapon system procurements to pay for rising operations and sustainment (O&S) costs on existing equipment. This shift from procurement to O&S (termed 'procurement holiday') and "with the defense industry just recovering from dramatic post-Cold War cuts in spending" Defense officials argue the industry "cannot afford another 'procurement holiday (Freedberg Jr., 2000).'"

The 1990s forced a lot of companies out of the defense market, as stock prices and new procurement projects declined. Robert Friedman, an aerospace and defense analyst with Standard & Poor's Equity Group, said "defense stocks made a quick downturn early in the Clinton

Administration after [former President] Clinton invited industry executives to Washington and [Clinton] said 'there's not enough business after the Cold War for all of you (Daniel, 2001).'

Even Defense Secretary Rumsfeld acknowledged the "three top defense contractors in size, Boeing and Raytheon and Lockheed [Martin], had a market cap[italization] that was less than Wal-Mart...[b]ecause doing business with the government is not a great deal (Mann, 2001)."

Today, defense contractors are large conglomerates that have merged from smaller companies in order to take advantage of economies of scale. These mergers were, in most cases, necessary for their survival. "Over the past decade, virtually every tier of the industry from major prime contractors to suppliers have consolidated through a series of deals that have lead to a far fewer number of larger and more vertically integrated companies (Muradian and Wolfe, 2001)." This consolidation is troubling to some because less competition means less innovation and opportunities to develop and exploit new technologies. Regardless, Pete Aldridge, Under Secretary of Defense (Acquisition, Technology, and Logistics) views improving the strength of the defense industrial base as a priority for DoD. When asked what his priorities were, he said, "Improving the health of the nation's defense industrial base would rank high on any list of goals (Muradian and Wolfe, 2001)."

3. New Technology and the Defense Industry: DoD's Lifeline

From the above paragraphs, it should be apparent that new technology and the defense industry are extremely important to DoD's ability to fight and win wars. The Defense Department relies on industry to develop weapon systems that incorporate the latest technology so that its forces will remain superior throughout the world. These weapon systems are used to protect our national security and implement our national military objectives.

Under Secretary Aldridge said, "The health of the defense industrial base is extremely important to national security and we have to make sure the industry gets the proper support (Muradian and Wolfe, 2001)." Therefore, to maintain national security, the United States must ensure that the defense industry remains an attractive business to make a profit and support shareholders goals. Aldridge acknowledges this saying, "We have to make sure that we recognize that in the government and that the government's objective in turn is to get the absolute highest quality weapon systems. For that to happen, the industry has to stay a viable business where government and corporate objectives coincide (Muradian and Wolfe, 2001)." It is for these reasons that the decision was made to focus on how DoD and the defense industrial base would be impacted if current weapon systems in development are skipped and if it is realistic to skip a generation of weapon system technology.

C. METHODOLOGY

Chapter II has already answered the subsidiary research questions:

- What does "skip a generation of technology" mean?
- How does the Department of Defense develop new technology into a weapon system?
- How does DoD determine when technology is mature?
- How long is a generation of weapon system technology?

The answers to these questions were obtained through the initial research, which included a thorough review of available literature: books, magazine and newspaper articles, Defense acquisition documents, Internet resources, and other library information resources relating to the DoD acquisition process and the "skip a generation of technology" proposal. A thorough search of DoD's current weapon systems inventory was done using the Internet and in order to compare how long different types of weapon systems technology lasts.

Interviews were conducted to answer the primary research questions listed below:

- In systems acquisition management, is it realistic to skip a generation of weapon system technology?
- How will the Department of Defense and the defense industrial base be impacted if weapon systems currently in development are skipped?

Contact was made with a variety of acquisition professionals within the Department of Defense. A total of eleven DoD employees were interviewed. The demographics of this group were as follows:

- Eight were active duty military

- Three were Government civilian personnel

Initially potential interviewees were contacted in person during their visits to the Naval Postgraduate School describing the nature of the research and requesting either an e-mail or telephone interview. Other potential interviewees were contacted through e-mail. A list of the interview questions was included in an e-mail to those that agreed to participate in the study. The questions were designed to focus on the impact that skipping weapon systems in development would have on DoD and the defense industrial base. The interviewees were informed that, because of the number of interviews being conducted, an e-mail interview was preferred. If this was not suitable, a telephone interview could be conducted at the convenience of the interviewee.

Each interviewee was informed that all information that they provided would be kept strictly confidential and neither their organization, their program, nor their names would be specifically identified. Program specific information was only asked for in order to help organize the data and ensure that data were being obtained about a number of different programs. The goal was to avoid obtaining duplicate data. The participants were assured that the findings would be presented as a group and would not identify or target any specific program. This was done so that the participants could answer all question honestly without any fear of possible reprisal or repercussions. The confidential information requested, and used for organizational purpose only, appears below:

Organization:

Interviewee:

Program:

Position and Title:

E-mail Address:

The following interview questions were used for each interview and appeared in the general format presented below:

General:

1. On a scale of 1 to 10, 10 being very important, how important do you think defense contracts are to your Contractor?

2. Is the program you are working on for the Army, Navy, Air Force, Marines or Coast Guard, and what is the nature of your program (aircraft, ship, tank, artillery, or vehicle)?

3. According to the DoD acquisition process, what phase of development is your program in?

4. How long has your weapon system been in development and how much longer do you think it will take before it is ready for Initial Operational Capability?

5. In terms of the product you are developing, how often does technology change to be classified as a "new generation" of technology?

6. For a major weapon system, the acquisition process takes a long time, while technological change is becoming more rapid. In your opinion, how can the acquisition process be streamlined to keep pace with technological innovations in order to field a weapon system more quickly?

7. Once your system is fielded, how long is the estimated service life of your weapon system before it is scheduled to be replaced?

8. Are you aware of the Bush Administration's proposal to skip current weapon systems under development in order to start research and development on newer generations of technology?

Impact on DoD:

1. Is there any technology available now that is newer or better than the technology that you are using in developing your weapon system and can it be incorporated into the system you are developing?

2. If your program were to be canceled, how long do you think it would take before a next generation system could be developed and fielded?

3. What do you think the DoD can do, in the interim, if your program were to be canceled in order to maintain current readiness and capabilities (upgrade current systems, leases, COTS systems until the next generation is available, etc)?

4. What do you feel the biggest impact, positive or negative, cancellation of your program would have on the Department of Defense?

5. Please add any additional comments regarding the impact that skipping a generation of weapons technology might have on the Department of Defense.

Impact on Defense Industrial Base:

1. If your program were to be canceled, how do you feel this would impact your Contractor's decision to pursue Government defense contracts in the future?

2. Do you feel that your Contractor will be competitive for bidding on the next generation weapon system?

3. If your program were to be skipped, what are some things that the Department of Defense and the U.S. Government could do to keep your Contractor in the defense industry?

4. If your program were to be canceled, do you think your Contractor will reallocate the resources currently used in development of your program (i.e. people, equipment, manufacturing capacity, etc) towards other DoD contracts or to other company interests?

5. Please add any additional comments on the impact that skipping a generation of weapons technology might have on your Contractor and/or the defense industrial base you are working in.

Feasibility of Skipping a Generation of Technology:

1. Do you think it is feasible for DoD to "skip" your program and still meet the current national threats and the threats of the future?

2. Please feel free to add any additional comments relating to the feasibility of skipping a generation of technology regarding your program or in general.

Once all the interviews were completed, the author combined the responses onto a master interview response sheet. The purpose of the master interview response sheet was to facilitate the sorting and analysis of the data.

D. SUMMARY

This chapter initially discussed the reasoning as to why the primary research question was selected. The primary research questions were once again presented:

- In systems acquisition management, is it realistic to skip a generation of weapon system technology?
- How will the Department of Defense and the defense industrial base be impacted if weapon systems currently in development are skipped?

Initial research provided insight into the DoD acquisition process and the "skip a generation of technology" proposal. DoD places great importance on the acquisition process to develop and incorporate new technology into a weapon system to maintain national security and implement the nation's National Military Strategy.

Next, the methodology of the study was discussed. The research participants, interview techniques of data collection and demographics of the study were presented. Finally, the interview questions were themselves presented. Along with this, quick reference was made to the master interview response sheet that was used to facilitate the sorting and analysis of the accumulated data.

IV. DATA PRESENTATION AND ANALYSIS

A. INTRODUCTION

This chapter contains a summary of interviews conducted by the author during October 2002. The purpose of the interviews was to acquire the data necessary to answer the primary research questions.

As presented in the previous chapter, the interview questions were structured to focus on the impact that skipping a generation of technology would have on the Department of Defense (DoD) and the defense industrial base as well as its feasibility. The data represent comments, opinions and personal experiences of those interviewed in regards to the ten questions concerning the impact on DoD and the defense industry and two questions regarding the feasibility of the proposal. The responses to each question are grouped so that the data can be presented together. Beginning at section "C" of this chapter, the questions are again presented in the sections that follow and are followed by the compiled data and a short analysis.

B. PARTICIPANTS AND THEIR PROGRAMS

Eleven DoD acquisition professionals were interviewed. Eight were active duty military members the other three were civilian Government personnel. Of the eight military members, five were program (or product) managers; one was a test manager; one a special projects officer; and one was in charge of the program's systems engineering division. Of the three civilians, one was a test branch team leader;

one was a team leader for multiple projects; and one was a program manager.

The eleven respondents were members of Army, Navy, Marine Corps, joint and Office of the Secretary of Defense (OSD) programs. These programs consisted of three aircraft programs, three ground combat vehicle programs, one artillery program, and four programs that would be categorized as other. On a scale of 1-10 (10 being very important) eight of the eleven answered 10 to how important defense contracts are to their contractor. Two answered nine and the other answered eight. Two of the respondents that answered 10, stated that they would rate their subcontractors 7 or less.

The programs span the entire DoD acquisition process. One program is in the Concept and Technology Development phase, five are in System Development and Demonstration phase, two are in Production and Deployment phase, two in Sustainment and Disposal phase and the OSD program answered not applicable. Two of the respondents with multiple programs also had programs in the Concept and Technology Development phase. Of the eight programs that have not yet reached the Sustainment or Disposal phase (the last phase of the acquisition process), three are aircraft programs, two are vehicle programs, one is an artillery program and two fill the other category.

One of the programs is a ship's self defense protection system and has been in development for 26 years with an Initial Operational Capability (IOC) date set for 2008. Two of the aircraft programs have been in development for 11 years with and IOC date of 2009, the

other, eight years with an IOC date of 2012. One of the vehicle programs has been in development since 1988 with and IOC date of 2008 and the other for two years with and IOC date of 2010. The artillery program began development in 1998 and entered IOC this year. Finally, the last program takes four years from development to IOC.

The technology rate of change for these programs ranged from every two years for the computer processing components; to eight years for the vehicles; to ten or more years for aircraft platforms. However, the service life of these programs ranged from 35 years for ship's component, 30 years for aircraft, 30 years for vehicles, 25 years artillery, and from five to 17 years for the other programs. These figures were fairly consistent with those that the author found in Chapter II. The respondents from the aircraft programs did not come from large fixed wing programs, which would explain the difference between the author's research and that of the respondents.

Knowing that it takes a long time to develop a weapon systems, the author asked the interviewees their opinion on how the acquisition process could be streamlined to capitalize on technological innovations in order to field systems more quickly. The interviewees were not limited to only one response. Most had more than one suggestion and, when totaled, they responded with 14 different suggestions. Table 1 lists the suggestions and the number of times the different interviewees made the suggestion. The most common responses dealt with stabilizing the program's budget early in the System Development and Demonstration phase, adjusting the Planning, Programming and Budgeting

System (PPBS), and using open-architecture designs to allow new technology to be incorporated during program development.

Suggestion	Number of Times Suggested
Stabilize the program's budget after Milestone B	Four
Adjust the Planning, Programming and Budgeting System (PPBS)	Three
Use open-architecture designs during development	Three
Combine developmental and operational testing	Two
Increase the amount of modeling and simulation	Two
Use performance based specifications	Two
Better use of off-the-self products	One
Use spiral development	One
Warfighter Rapid Acquisition Program (WARP)	One
Reduce documentation	One
Design systems with middle software layer	One
Use plug and play hardware	One
Develop a service wide RDT&E money pool	One
Nothing	One

Table 1. Suggestions To Improve The Acquisition Process

The last of the general questions asked whether or not the interviewee had heard of the President's "skip a generation of technology" proposal. Ten of the eleven respondents answered yes, only one answered somewhat.

C. COMPILED DATA AND ANALYSIS: SKIPPING A GENERATION OF TECHNOLOGY AND THE IMPACT ON THE DEPARTMENT OF DEFENSE

1. Question Area 1

The following question comprised question area 1:

Is there any technology available now that is newer or better than the technology that you are using in developing your weapon system and can it be incorporated into the system you are developing?

a. DoD Acquisition Professionals' Responses

Of the eleven acquisition professionals interviewed, nine responded yes. Most of the technology that they feel is newer or better is some type of computer processing capability or improved electronic equipment. Examples of improved electronic equipment include command, control, communication, computers and intelligence (C4I) technologies, fire control systems, and optical sight technology. One of the respondents who answered no, felt that his program is on the cutting edge of technology with respect to all aspects of his program. The eleventh respondent answered that it is too early in his program's development to determine if newer or better technology is available.

b. Analysis

The responses make it clear that there is newer and better technology available to program managers that can be incorporated into weapon systems as they undergo development. This further emphasizes the need to develop weapon systems using open system architectures and using a spiral development method to take advantage of computer processing and electronic equipment technological changes. It should be anticipated early that C4I and electronic equipment will be outdated before the system is fielded. Therefore, program managers should carefully plan for electronic equipment upgrades early in their acquisition strategy in order to make upgrades cost effective and prevent schedule slips.

2. Question Area 2

The following question comprised question area 2:

If your program were to be canceled, how long do you think it would take before a next generation system could be developed and fielded?

a. DoD Acquisition Professionals' Responses

The responses to this question varied from program to program. Two of the people working on aircraft programs stated that it would take anywhere from five to 15 years for a replacement to be developed and fielded. Two of the vehicle programs indicated that it could take anywhere from eight to 20 years. The ship's component program manager responded that it would take six to seven years. Three felt that this question did not apply because

of the nature of the program or because their program was already fielded. The last two did not know because they felt their programs are "next generational."

b. Analysis

Canceling a major weapon system could set the Department of Defense back anywhere from five to 20 years depending on the type of system. For some systems, it may not be known how long a replacement system can be fielded since the program is already working with the latest in technology. Therefore, DoD should not cancel any system without knowing the estimated length of time a replacement system will take to develop and the potential impact the cancellation might have on systems already fielded. In some cases where DoD is already on the cutting edge of technology, it may be more reasonable to provide the program with additional resources to speed up development than cancel the program, because the replacement systems may only provide marginal improvements in technology that do not justify the additional costs incurred.

3. Question Area 3

The following question comprised question area 3:

What do you think the DoD can do, in the interim, if your program were to be canceled in order to maintain current readiness and capabilities (upgrade current systems, leases, COTS systems until the next generation is available, etc)?

a. DoD Acquisition Professionals' Responses

Four of the respondents recommended some kind of upgrade to the system currently fielded. However, these four agreed this would be costly and not provide the same capabilities that the current system they are developing will provide. Four others recommended increasing the operations and sustainment (O&S) funding for the current systems to keep them supportable. Several implied that the systems they are replacing have subcomponents that are no longer capable of being manufactured. One responded that DoD would have to hope for the best because the hardware currently being used is obsolete. Another stated that without his program, DoD would have to strictly rely on data generated from modeling and simulation. The last respondent stated that this question did not apply to any of his programs.

b. Analysis

Some of the respondents felt that canceling their program would lead to an increase in O&S costs and diminishing system performance. Others felt that some type of service life extension program (SLEP) would have to be done to the older systems in order to provide some increase in capability. As was presented in Chapter II, O&S costs during the 1990s have steadily consumed a growing portion of the DoD budget. This has left the military with older, outdated systems that are too costly to maintain. Likewise, these older systems' performance have been degraded as they continue to age and their operational availability has decreased. These rising costs come at the expense of new programs, as procurement dollars are used to

supplement O&S costs. Short-term solutions like SLEP or increasing O&S funding will not prevent this cycle. Therefore, DoD should expect to see the procurement death spiral accelerated if current programs are canceled.

4. Question Area 4

The following question comprised question area 4:

What do you feel the biggest impact, positive or negative, cancellation of your program would have on the Department of Defense?

a. DoD Acquisition Professionals' Responses

Six of the respondents said canceling their program would have some kind of negative impact on DoD. One of these who responded negatively said that it would "eliminate the most important transformation enabler in DoD." Another stated that it would cost DoD 10% more each additional year to maintain the older systems. Two others stated canceling their program would put people at risk while one program manager put it more bluntly, "Marines would die unnecessarily if we had to fight a real fight in the next 4-10 years."

One respondent answered both positively and negatively. He said "positive" in the sense that DoD would save \$10 billion over the life of the program, but "negative" in that the Army would lose world dominance in four critical mission areas. There were two people who responded unknown and two more who replied the impact would be very little.

b. Analysis

Seven of the eleven indicated that there would be a negative impact if their programs were canceled. All of these respondents are developing major weapon systems. Therefore, they believe that canceling a major weapon system will degrade the capabilities of DoD to fight and win wars and expose military personnel to higher levels of risk under combat situations. Furthermore, some of the systems are being developed to complement other systems currently fielded. Therefore, canceling these systems potentially can degrade the future combat capability of existing systems.

If DoD were to cancel a smaller program, the impact would be minimal. Most likely the service developing the system would be impacted but other services wouldn't. This is best illustrated by one response that said, "On the macroscopic level - not much. However, there could be significantly diminished ship self-protection capability in the advent of a shooting war."

5. Question Area 5

The following statement comprised question area 5:

Please add any additional comments regarding the impact that skipping a generation of weapons technology might have on the Department of Defense.

a. DoD Acquisition Professionals' Responses

There were two different types of responses to this request. One type was clearly skeptical that skipping a generation would provide DoD with any benefits and felt

that DoD would fail to capture the technological advances already being made through existing programs. The other side felt that canceling some weapon systems, by making a vertical budget cut, was a better approach than making a horizontal cut and reducing all program budgets across the board. However, they clarified this position with the statement that DoD first must address the prolonged sustainment problems of older systems that will result from canceling programs and address the additional risks that will occur.

b. Analysis

Canceling a weapon system in development must be done on a case-by-case basis. Careful consideration must be made to determine the potential impacts to the services and to the Defense Department. A thorough risk assessment must be done to mitigate the unforeseen consequences that will occur in the future. Furthermore, DoD should be prepared to provide existing systems with additional resources until the next-generation system is fielded.

That being said, canceling one weapon system program may be a better strategy than making horizontal cuts to all programs. As indicated earlier, unstable budgets are the major reason weapon systems take a long time to develop using the acquisition process. This strategy will only work, however, if the cost savings are greater than the additional O&S costs that will result.

D. COMPILED DATA AND ANALYSIS: SKIPPING A GENERATION OF TECHNOLOGY AND THE IMPACT ON THE DEFENSE INDUSTRIAL BASE:

1. Question Area 1

The following question comprised question area 1:

If your program were to be canceled, how do you feel this would impact your Contractor's decision to pursue Government defense contracts in the future?

a. DoD Acquisition Professionals' Responses

Answers to this question ranged from no impact to severe depending on the type of contractor. The respondents felt that the larger companies that have several other defense contracts or other commercial products would not be affected much by a cancellation. However, the respondents mentioned that the subcontractors on these programs would likely go out of business. One respondents said, because of the size of the contract, that some of his contractors "would go out of business, others would most likely not pursue Government contracts in the future."

One respondent explained that he has very little choice when picking contractors because of the downsizing that has affected the industry. Most likely, he said, cancellation would result in "limiting choices for solution providers and most likely costing the Government more money."

b. Analysis

DoD acquisition professionals interviewed feel that the bigger defense contractors will likely not be

affected much by a program cancellation. However, the smaller companies who support the prime contractors will most likely go out of business or not do business with the Government in the future. This is very significant because the amount of outsourcing by contractors is increasing. The fact that subcontractors may leave the industry will have a negative affect on DoD in future acquisition programs. Also, the current systems already fielded rely on smaller companies for spare part support. Furthermore, it is likely that future programs will be more costly if contractors perceive a greater risk doing business with the Government because of their programs and others that have been canceled in the past.

2. Question Area 2

The following question comprised question area 2:

Do you feel that your Contractor will be competitive for bidding on the next generation weapon system?

a. DoD Acquisition Professionals' Responses

Six of the interviewees responded yes. Two responded that some, but not all will be competitive for future contracts. One indicated that it is too soon to tell if his contractor will be competitive. Another stated that his contractor had already won the follow-on contract to his system. He maintained that this is a problem with the industry as a whole, in that there is very little competition. Also, he mentioned that one of the unfortunate consequences of the performance specifications

is that the designs are essentially proprietary, limiting the amount of competition for follow-on contractors.

The eleventh responded that as long as his contractors see an opportunity to make a profit, his contractors would continue to pursue defense contracts. He cautions that "if a contract was cancelled and cost the contractor money, they may be looking to recoup on the next one."

b. Analysis

It is safe to say that all current prime contractors will be competitive for future contracts. None of the respondents indicated that this is a concern. However, canceling programs will come at the price of higher payouts for future contracts later as contractors try to recoup losses or offset new risks.

3. Question Area 3

The following question comprised question area 3:

If your program were to be skipped, what are some things that the Department of Defense and the U.S. Government could do to keep your Contractor in the defense industry?

a. DoD Acquisition Professionals' Responses

Nine out of the eleven respondents answered either that this is not an issue; the contractor has already mitigated this risk so it is not necessary; or none. Two respondents did provide suggestions. The other two said that the Government could provide the contractor

with some of the sustainment business that would necessitate keeping the older system operating longer. In addition, the Government could fund the contractor for technology insertions and upgrades to existing systems.

b. Analysis

Motivating defense contractors to stay in the defense industry does not seem to be a problem. Most contractors either have contracts in other areas of the defense industry. However, to alleviate some of the impact after a program has been canceled, the Government should be prepared to offer the contractor sustainment and future upgrade contracts. These payments may prevent the contractor from trying to recoup losses on future contracts.

4. Question Area 4

The following question comprised question area 4:

If your program were to be canceled, do you think your Contractor will reallocate the resources currently used in development of your program (i.e. people, equipment, manufacturing capacity, etc) towards other DoD contracts or to other company interests?

a. DoD Acquisition Professionals' Responses

Ten of the respondents indicated that their contractors would reallocate resources by moving people and capital to other projects and/or by laying off workers. One of these said "the contractor will downsize some of his staff" and that this would "create a loss of experience

that could not be replaced." Another said that his contractor would likely lay some people off and shift the additional overhead costs to other Government programs. The eleventh respondent felt that this question did not apply to his program.

b. Analysis

The overwhelming number of "yes" answers indicates that there will be some adverse affect on the market sectors within the defense industry that has a program canceled. This would result in the loss of people and equipment as they get transferred to other areas of the defense industry or get laid off. The impact on DoD will come in the form of longer development times for similar programs because the future labor force will have to train to regain the skills that will be lost. Likewise, other existing programs are likely to see increases in labor prices as these programs absorb the displaced workers.

5. Question Area 5

The following statement comprised question area 5:

Please add any additional comments on the impact that skipping a generation of weapons technology might have on your Contractor and/or the defense industrial base you are working in.

a. DoD Acquisition Professionals' Responses

Three of the respondents provided additional comments regarding the impact on the defense industrial base. One said that "labor rates on other aviation

programs would sky rocket possibly causing a wide spread cost breach" for other aviation programs. Another said that the loss of skilled labor used in the production of his system, if canceled, would take years to rebuild. Finally the third respondent stated something similar to that of the second in that "The real industrial base is intellectual capital. Once lost, this will take years to reestablish."

b. Analysis

These three statements further emphasized that biggest impact on the defense industrial base will be the loss of an experienced labor force. This experience is needed to develop the next-generation weapon systems. Therefore, DoD will have to strike a balance between canceling outdated weapon systems currently in development and protecting the intellectual capital of that market sector.

E. COMPILED DATA AND ANALYSIS: FEASIBILITY OF SKIPPING A GENERATION OF TECHNOLOGY

1. Question Area 1

The following question comprised question area 1:

Do you think it is feasible for DoD to "skip" your program and still meet the current national threats and the threats of the future?

a. DoD Acquisition Professionals' Responses

The respondents' answers to this question were split between yes and no. Only one person who answered no

gave an explanation. He said, "No, it is not feasible. This program in essence skips to a much more significant level of capabilities than the current system."

Those that responded yes clarified their statement with the potential consequences. One said, "Feasible yes; desirable from a national security perspective no." Another said that it was feasible with the expectation of higher costs elsewhere. Still another responded, "Yes, as long as sustainment funding is identified to keep the current fleet out there." Finally, another responded that it was not feasible "without assuming some risk in the near future."

b. Analysis

The feasibility of skipping a generation of technology depends on the program at stake. Those respondents that feel their programs are next generational believe that it is not feasible to skip their program. The others believe it is possible but at higher risks and only if more sustainment funding for older systems is provided. These reactions support the divided opinions found in the literature regarding skipping weapon systems currently in development that appear to be no longer relevant.

2. Question Area 2

The following statement comprised question area 2:

Please feel free to add any additional comments relating to the feasibility of skipping a generation of technology regarding your program or in general.

a. DoD Acquisition Professionals' Responses

Two of the respondents were very concerned with the idea of skipping a generation of technology. One raised a question on how the next generation of technology will be measured. He asks, "Do you base it on the next generation of computer chips which turn over about every 18 months, or the next electronics breakthrough which is about every 36 months, or the next major weapon system which takes about 10 years? The longer the skip the greater the risk that must be assumed." The other was skeptical about the proposal and was concerned that DoD will start a new downward spiral. He said, "If we continue down this path, we will continue to skip current technology for what appears to be better and more desirable future technology, resulting in our inability to ever get to the end game, fielding new equipment."

b. Analysis

The statements above highlight the difficulty of skipping a generation of weapon systems technology. They raise concern that this might be the wrong direction that DoD is heading. Instead of skipping technology, they believe DoD should focused on getting the current systems in development fielded so that newer and better equipment will reach the warfighter.

F. SUMMARY

This chapter presented the data for the thesis, a summary of eleven interviews conducted by the author during October 2002. The respondents were DoD acquisition

professionals from the different services. The interviews consisted of ten questions regarding the impact the skipping a generation of technology would have on the DoD and the defense industry and, the two questions regarding its feasibility. The objective of the interviews was to answer the primary research questions:

- In systems acquisition management, is it realistic to skip a generation of weapon system technology?
- How will the Department of Defense and the defense industrial base be impacted if weapon systems currently in development are skipped?

The questions areas were first presented, and then followed by a summary of responses. An analysis of this data immediately followed each question area response. The intent was to identify any major differences in the experiences and opinions of the interviewees with the research literature presented in Chapter II.

V. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This thesis has examined the impact that skipping a generation of technology would have on the Department of Defense (DoD) and the defense industry. The desired result of the study was to determine the feasibility of implementing the President's "skipping a generation of technology" proposal.

In section "B" of this chapter are the answers to the primary research questions:

- In systems acquisition management, is it realistic to skip a generation of weapon system technology?
- How will the Department of Defense and the defense industrial base be impacted if weapon systems currently in development are skipped?

This section also provides recommendations developed as a result of this study. Section "C" identifies some potential areas for future research.

B. CONCLUSIONS AND RECOMMENDATIONS

Lieutenant General Paul J. Kern, Director of the Army's Acquisition Corps stated:

The current acquisition process was good for producing systems in the Cold War environment, where we had a predictable enemy with known lead times. Now, many of our foreseeable potential enemies are different: they are not constrained by a rigid, inflexible acquisition process. They can purchase weapon systems and/or sub components in an open-air market environment, like a global of-the-shelf system. Through mixing a matching various weapon systems and subsystems, they can

rapidly generate some very lethal systems. We lose if they can purchase and bring together their systems faster than we can develop ours because of long cycle times (Johnson, McKeon and Szanto, 1998).

It is because of this fear that President Bush has proposed transforming and reforming the DoD acquisition process. Getting weapon systems that incorporate the latest technology and meet our ability to counter national threats is the ultimate goal of his proposal. Therefore, the research conducted in this thesis indicates that it is possible to skip a generation of weapon system technology in the developmental process. However, before the decision to cancel a program is made, careful consideration must be made about the impact the cancellation will have on the supportability of the existing weapon system and the consequences that will occur for DoD and that sector of the defense industry.

1. Primary Research Question: In Systems Acquisition Management, Is it Realistic to Skip a Generation of Weapon System Technology?

It is realistic to skip a generation of weapons system technology. However, whether it is more or less realistic depends on the weapon system program. For weapon system programs that are already on the cutting edge of technology, like the Army's RAH-66 Comanche Scout Light Attack Helicopter and the Marine Corps' Advanced Amphibious Assault Vehicle, cancellation becomes a more difficult decision. These programs offer technology that provides a more significant level of technology than the aging system they are designed to replace. Therefore, canceling these

"next-generational" programs would put DoD anywhere from five to 20 years further behind current technology. Likewise, the steadily increasing operations and sustainment (O&S) costs needed to sustain the current systems may negate the perceived benefits from the program cancellation.

Skipping smaller programs and programs that offer only marginal improvements in technology, have designs that are no longer relevant, and when the system it is designed to replace can be upgraded and maintained at minimal additional costs, are less difficult decisions. Skipping a "non-next generational" weapon system to reprogram DoD or service funding is a better alternative than making horizontal programming cuts to several program budgets to free the same amount of funding. The unstable budgets of the past are one of the reasons the acquisition process takes a long time.

Similarly, canceling weapon system programs in development that no longer are relevant to the threat environment that DoD faces, will help facilitate the transformation of the Defense Department to a light and mobile force with more high-tech weapons. The additional funding obtained through cancellation could provide additional resources to DoD acquisition priorities and accelerated their development cycle time.

2. Primary Research Question: How Will the Department of Defense and the Defense Industrial Base Be Impacted if Weapon Systems Currently in Development Are Skipped?

The Department of Defense will be impacted through higher O&S costs to sustain existing weapon systems if weapon systems currently in development are skipped. The acquisition professionals that participated in this study believe these O&S costs could increase up to 10% per year for anywhere from five to 20 years depending on the type of system. Furthermore, the performance capabilities of the existing systems are likely to diminish, as they are extended beyond their intended life span, and will likely have to undergo service life extension programs.

Skipping weapon systems currently in development will not affect the large contractors in the defense industry. Most of the large defense contractors have diversified in other areas of the defense industry and the commercial sector to mitigate this risk. However, the smaller companies who support these contractors will most likely go out of business or not do business with the Government in the future. The loss of these subcontractors will have a negative affect on future DoD acquisition programs and for some current systems that rely on these smaller companies for spare parts support.

Perhaps the biggest impact on the defense industrial base will be the loss of an experienced labor force. This experience is needed to develop the next-generation of weapon systems. Losing this labor force will affect the defense industry's ability to development similar programs in the future. Therefore, DoD will need to have a plan in place prior to canceling weapon systems currently in development to protect the intellectual capital of that market sector.

3. Recommendations

Analysis of the data collected and presented throughout the study leads to the following four recommendations.

a. Recommendation #1

A fifth main area to the "skip a generation of technology" should be revising the Planning, Programming, and Budgeting System (PPBS). In order to develop and field the weapon systems with the latest technology, program managers need sustained and consistent funding. Unstable budgets prevent the timely execution of program schedules. Therefore, PPBS should be revised to allow for event driven program schedules and to give the program manager the flexibility to reprogram the program's production and O&S funds to the research, development, test and evaluation effort if it will allow for the incorporation of the latest technology.

b. Recommendation #2

In order to guarantee that existing weapon systems are provided sustainment funding, the Executive Branch officials should ensure that the canceled program's funding stays within the Department of Defense, if it is a joint program, and within the service if a service level program is canceled. This will provide the department and the service with the additional O&S funding needed to sustain the weapon systems until the next-generation replacement system is fielded. Likewise, the department or service should be allowed to reprogram the canceled

program's budget to other alternative programs in development. This will help speed the development of other programs in the acquisition process and ensure that the warfighter has access to the latest in military technology.

c. Recommendation #3

Program managers should be encouraged to use open-system architectures when developing weapon systems. An open-system architecture will allow for the incorporation of newer and better technologies when they materialize. In particular, open-system architectures should be used in the areas of the systems that interface with the computer processing and the electronic components. Computer processing and the electronic components have a two-year technology rate of change.

d. Recommendation #4

The Government should commit early in the development process that if the weapon system is canceled, the Government would provide the same contractor with sustainment, upgrade and technology insertion contracts for the weapon system currently fielded. This will reduce the contractor's risk to accept DoD contracts and, will help keep subcontractors and the experienced labor force in the defense industry.

C. RECOMMENDATIONS FOR FURTHER RESEARCH

The research has highlighted many areas for future research. The following areas of study are recommended:

- Compare the new acquisition guidance issued after the cancellation of the DoD 5000 series to the "Skip a Generation of Technology" Proposal.
- Look at how the cancellation of the DoD 5000 series will affect the acquisition process.
- Analyze and make recommendations as to how the PPBS process can be revised so that Congress still maintains control but provides more consistent program funding.
- Perform a cost-benefit analysis of skipping a weapons system currently in development.
- Give a similar questionnaire to the one used in this thesis to defense contractors and compare their responses to those that participated in this thesis.

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APPENDIX A. NINE TRLS

TECHNOLOGY READINESS LEVELS

Technology Readiness Level	Description
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of technology's basic properties.
2. Technology concept and/or application formulated.	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3. Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment.	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
5. Component and/or breadboard validation in relevant environment.	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high

	fidelity" laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment.	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.
7. System prototype demonstration in an operational environment.	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as and aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operation mission conditions.

Table 2 Technology Readiness Levels. (From: DoD 5000.2-R, April 5, 2002, Appendix 6)

DEFINITIONS

BREADBOARD: Integrated components that provide a representation of a system/subsystem and which can be used to determine concept feasibility and to develop technical data. Typically configured for laboratory use to demonstrate the technical principles of immediate interest. May resemble final system/subsystem in function only.

"HIGH FIDELITY": Addresses form, fit and function. High-fidelity laboratory environment would involve testing with equipment that can simulate and validate all system specifications within a laboratory setting.

"LOW FIDELITY": A representative of the component or system that has limited ability to provide anything but first order information about the end product. Low-fidelity assessments are used to provide trend analysis.

MODEL: A functional form of a system, generally reduced in scale, near or at operational specification. Models will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.

OPERATIONAL ENVIRONMENT: Environment that addresses all of the operational requirements and specifications required of the final system to include platform/packaging.

PROTOTYPE: A physical or virtual model used to evaluate the technical or manufacturing feasibility or military utility of a particular technology or process, concept, end item or system.

RELEVANT ENVIRONMENT: Testing environment that simulates the key aspects of the operational environment.

SIMULATED OPERATIONAL ENVIRONMENT: Either 1) a real environment that can simulate all of the operational requirements and specifications required of the final system, or 2) a simulated environment that allows for testing of a virtual prototype; used in either case to determine whether a developmental system meets the operational requirements and specifications of the final system.

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APPENDIX B. BREAKDOWN OF EACH TYPE OF WEAPON SYSTEM CATEGORY

WEAPON SYSTEM LIFE SPAN ANALYSIS

AIRCRAFT

Weapon Sys	Type System	IOC Date	Retire Date	Years	Remarks
Aircraft					
A-4	Attack/Fighter	1956	1985	29	Replaced by the AV-8B in the Marine Corps (1)
A-6	Attack/Fighter	1963	1997	34	Phased out in 1997 (1)
A-7	Attack/Fighter	1966	1992	26	Last active-duty squadron in 1992 (1)
AV-8B	Attack/Fighter	1985	2018	33	USMC expects to operate AV-8Bs until 2018 (1)
A-10	Attack/Fighter	1977	2008	31	Upgrades in 2001 will maintain capability to 2008 (1)
A-37	Attack/Fighter	1967	1987	20	Replaced by the OA-10 (1)
F-4	Attack/Fighter	1961	1989	28	Navy retired in 1986, USMC in 1989 (1)
F-14	Attack/Fighter	1973	2008	35	Expected to remain in service at least until 2008 (1)
Attack/Fighter Average				29.5	
B-52	Large F. Wing	1955	2030	75	Air Logistics Command estimates use until 2030 (1)
C-9	Large F. Wing	1966	2015	49	Estimate, likely to remain in service well into the 21st Century (2)
C-22	Large F. Wing	1963	2003	40	Projected FOC date for replacement is FY 2003/4 (3)
C-135	Large F. Wing	1957	2040	83	AMC is charged with maintaining the KC-135 fleet until 2040 (4)
C-130	Large F. Wing	1956	2028	72	30 yr life est for C-130J, Congress approved acq."J's" in 1998 (5)
C-141	Large F. Wing	1965	2005	40	C-17 due to replace the C-141 in 2005 (1)
P-3	Large F. Wing	1962	2015	53	Multi-Mission Aircraft to replace the P-3 in 2015 (1)
Large F. Wing Average				58.9	
AH-1	Helicopter	1967	2035	68	AH-1Z est. service of 30 yrs, the re-man. will add 10,000 flt hrs (6)
CH-46	Helicopter	1962	2013	51	2013 the MV-22 will become the transport for the USMC (1)
CH-47	Helicopter	1962	2014	52	Upgrade program will start in 2002 and end in 2014 (1)
CH-53	Helicopter	1966	2025	59	CH-53E to be operational until 2025 (7)
OH-58	Helicopter	1968	2020	52	Army scheduled to keep OH-58's until 2020 (1)
Helicopter Average				56.4	
Aircraft Averages				48.3	

Table 3. Aircraft Life Span Analysis.

- (1) Ref: Periscope, 2002.
- (2) Ref: Boeing, 2002.
- (3) Ref: Davis, April 19, 2000.
- (4) Ref: Stevenson, October, 12, 1999.
- (5) Ref: Lockheed Martin Press Release, August 24, 1998.
- (6) Ref: FAS/AH-1W, December 27, 1999.
- (7) Ref: FAS/CH-53, January 7, 1999.

ARTILLERY, GROUND COMBAT VEHICLES, AND MISSILES/ROCKETS/TORPEDOES

Weapon Systems	Type System	IOC Date	Retire Date	Years	Remarks
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Artillery					
M107 175mm	Self-Propelled	1963	1981	18	Converted to M110s in 1981 (1)
M114 155mm	Towed	1942	1980	38	The M198 was introduced in the early 1980's (1)
M109 155mm	Self-Propelled	1963	2008	45	Replacement Crusader, was scheduled for IOC in 2008 (1)
M110 203mm	Self-Propelled	1963	1995	32	Phased out of service in the 1990s (8)

Artillery Averages	33.3				
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Ground Combat Vehicles					
M163 Vulcan	Air Defense	1968	1991	23	Retired after being withdrawn from Europe (1)
LAV-150	Arm. Per. Car	1964	2015	51	LAV structural integrity is sustainable at least through 2015 (9)
M113	Arm. Per. Car	1959	2006	47	Plans for a new vehicle call for integration in 2006 (10)
AAV7	Amph. Aslt	1972	2008	36	Will be replaced by the AAV (1)
LVTP-5	Amph. Aslt	1956	1974	18	Out of service by the USMC in 1974 (1)
M88 ARV	Combat Sup	1961	1996	35	Existing M88A1s are to be converted to M88A2s (1)
M1 Abrams	Tank	1978	2020	42	Army to continue M1A2 production through 2020 (1)
M60	Tank	1961	1997	36	All M60 series tanks were to be replaced in 1997 (11)

Ground Combat Vehicles Averages	36				
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Missiles/Rockets/Torpedoes					
AGM-114	Anti-Tank	1985	2020	35	Estimate, upgrade to be in service by 2007 (12)
AGM-78	Anti-Radar	1968	1984	16	Retired in 1984 after the F-105 was disposed of
AGM-45	Anti-Radar	1963	2000	37	Scheduled to remain in service until 2000
AIM-4F	Anti-Air	1956	1988	32	Retired in 1988
AIM-7	Anti-Air	1958	2010	52	Estimate, AIM-7M production ended in 1990
AIM-54	Anti-Air	1974	2008	34	Used on the F-14, F-14 retirement date is 2008
Mk 46	Torpedo	1966	2015	49	Expected to remain in Navy service until 2015 (13)
NT-37	Torpedo	1974	2027	53	NAMS is committed to supporting NT-37 for 25 years (14)

Missiles/Rockets/Torpedoes Average	38.5				
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Table 4. Artillery, Ground Combat Vehicles, and Missiles/Rockets/Torpedoes Life Span Analysis.

(1) Ref: Periscope, 2002.

(12) Ref: Jane's/AGM-114, October 13, 2000.

(8) Ref: FAS/M110A2, September 12, 1998.

(13) Ref: United States Navy Fact File, 2002.

(9) Ref: FAS/LAV, December 20, 2001.

(14) Ref: Scott, 2002.

(10) Ref: FAS/M113A1, February 5, 2000.

(11) Ref: Jane's/M60, March 12, 2002.

SHIPS

Weapon Sys	Type System	Commiss	Decomm	Years	Remarks
Ships/Class					
Nimitz	Aircraft Carrier	1975	2025	50	Service life expected to be 50 years (15)
Kitty Hawk	Aircraft Carrier	1961	2018	57	John F. Kennedy to be decommissioned in 2018 (1)
Forrestal	Aircraft Carrier	1955	1998	43	Independence decommissioned in 1998 (1)
Aircraft Carrier Average				50	
Tarawa	Amphibious	1976	2010	34	Scheduled to be replaced by Wasp class in 2010 (1)
Austin	Amphibious	1964	2008	44	Last LPD scheduled for retirement in 2008 (1)
Anchorage	Amphibious	1969	2007	38	Last LSD scheduled for retirement in 2007 (1)
Amphibious Average				38.7	
Knox	Frigate	1969	1995	26	Entire class was stricken in 1995 (1)
O. H. Perry	Frigate	1977	2021	44	Last ship in class to be decommissioned in 2021 (1)
Virginia	Cruiser	1976	1998	22	Last ship in class decommissioned in 1998 (1)
Long Beach	Cruiser	1961	1995	34	Decommissioned in 1995 (1)
California	Cruiser	1974	1999	25	Entire class was stricken in 1999 (1)
Bainbridge	Cruiser	1962	1996	34	Decommissioned in 1996 (1)
Kidd	Destroyer	1981	1999	18	Last ship in class decommissioned in 1999 (1)
F. Sherman	Destroyer	1955	1983	28	Last ship in class decommissioned in 1993 (1)
C. F. Adams	Destroyer	1959	1992	33	Last ship in class decommissioned in 1992 (1)
Frigate/Cruiser/Destroyer Average				29.3	
Sturgeon	Submarine	1967	2000	33	Last ship in class decommissioned in 2000 (1)
Ethan Allen	Submarine	1962	1985	23	Last ship in class decommissioned in 1985 (1)
Permit	Submarine	1967	1996	29	Last ship in class decommissioned in 1996 (1)
Narwhal	Submarine	1969	1999	30	Decommissioned in 1999 (1)
LaFayette	Submarine	1963	1994	31	Last ship in class decommissioned in 1994 (1)
GP Lipscomb	Submarine	1974	1990	16	Decommissioned in 1990 (1)
Ben Franklin	Submarine	1965	1999	34	Last ship in class decommissioned in 1999 (1)
Submarine Average				28	
Ships Average				36.5	

Table 5. Ships Life Span Analysis.

(1) Ref: Periscope, 2002.

(15) Ref: FAS/CVN-68, January 8, 2000.

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LIST OF REFERENCES

1. Asker, James R., *Pay Up Or Die*, Aviation Week & Space Technology, January 22, 2001.
2. Associated Press, *Pentagon Official Skeptical About Osprey*, Fox News.com, August 8, 2002.
3. Boeing, McDonnell Douglas History, *DC-9/C-9 Military Transport*, [<http://www.boeing.com/companyoffices/-history/mdc/dc-9.html>], 2002.
4. Borosage, Robert L., *Rumsfeld's Surrender*, The Washington Post, February 7, 2002.
5. Cohen, Eliot A., *Defending America in the Twenty-first Century*, Foreign Affairs, November/December 2000.
6. Coolidge, Shelley Donald, *Defense Industry Goes With Guns, Not Butter Recent Merger of Two Defense Companies Fits Growing Trend*, The Christian Science Monitor, April 6, 1995.
7. Crawley, Vince and Maze, Rick, *Crusader Might Not be Rumsfeld's Only Target: Other Next-Generation Weapons Also Could Be on the Chopping Block*, Marine Corps Times, June 3, 2002.
8. Daniel, Lisa, *Profiting from Change*, National Guard Magazine, September 2001.
9. Davis, Russell C., *Operational Requirements Document C-X (C-22B) Replacement Program*, Air National Guard, April 19, 2000.
10. DoD 5000.2-R, *"Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs*, Department of Defense, January 4, 2001.
11. DoDD 5000.1, *The Defense Acquisition System*, Department of Defense, October 23, 2000.
12. DoDI 5000.2, *Operation of the Defense Acquisition System*, Department of Defense, January 4, 2001.

13. Eland, Ivan, *Bush Versus the Defense Establishment? Issues in Science and Technology*, vol. 17, issue 4, Washington D.C., Summer 2001.
14. FAS Military Analysis Network, *AH-1W Super Cobra*, [<http://www.fas.org/man/dod-101/sys/ac/ah-1.htm>], December 27, 1999.
15. FAS Military Analysis Network, *CH-53 Sea Stallion*, [<http://www.fas.org/man/dod-101/sys/ac/h-53.htm>], January 7, 1999.
16. FAS Military Analysis Network, *CVN-68 Nimitz-class*, [<http://www.fas.org/man/dod-101/sys/ship/cvn-68.htm>], January 8, 2000.
17. FAS Military Analysis Network, *Light Armored Vehicle (LAV)*, [<http://www.fas.org/man/dod101/sys/land/lav.htm>], December 20, 2001.
18. FAS Military Analysis Network, *M110A2 Self-Propelled Howitzer*, [<http://www.fas.org/man/dod101/sys/land/m110a2.htm>], September 12, 1998.
19. FAS Military Analysis Network, *M113A1 Armored Personnel Carrier*, [<http://www.fas.org/man/dod101/sys/land/m113.htm>], February 5, 2000.
20. Financial Management In The Armed Forces, *PPBS Overview*, The Naval Postgraduate School, 2002 [http://pcc.nps.navy.mil/PPBS/PPBS_Overview/ppbs_Overview.html].
21. Freedberg Jr., Sydney J., Gore, *Bush Stake Out Positions on Defense Management*, Government Executive Magazine, April 4, 2000.
22. Hartung, William D., *War Shouldn't Bar U.S. Military Cuts*, [<http://www.commondreams.org>], January 7, 2002.
23. Hellman, Chris, *The Bush Administration: What Can We Expect for the Pentagon?* [<http://www.foreignpolicy-infocus.org>], November-December 2000.

24. Inspector General, Department of Defense Audit Report: *V-22 Osprey Joint Advanced Vertical Aircraft*, Inspector General, Department of Defense, August 15, 2000.
25. *Introduction To Defense Acquisition Management*, 5th Ed., Department of Defense Systems Management College, January 2001.
26. Jane's, *AGM-114 Hellfire*, [http://www.janes.com/defence/air_forces/news/jalw/jalw001013_1_n.shtml], October 13, 2000.
27. Jane's, *All the World's Aircraft 2002-2003*, [<http://www.Janes.com>, key word: Boeing/F/A-18E/F], March 19, 2002.
28. Jane's, *All the World's Aircraft 2002-2003*, [<http://www.Janes.com>, key word: Lockheed Martin/F-22], March 19, 2002.
29. Jane's, *All the World's Aircraft 2002-2003*, [<http://www.Janes.com>, key word: Bell Helicopter Textron and the Boeing Co./V-22], July 18, 2002.
30. Jane's, *All the World's Aircraft 2002-2003*, [<http://www.Janes.com>, key word: Boeing Co. and Sikorsky Aircraft/RAH-66], September 19, 2001.
31. Jane's, *Armour and Artillery 2002-2003*, [<http://www.Janes.com>, key word: United Defense/Crusader], February 12, 2002.
32. Jane's, *US Defence Industry*, [<http://www.Janes.com>, keyword: US defense industry], June 19, 2002.
33. Jane's, *General Dynamics Land Systems M60 Series of MBT*, [<http://www.janes.com> keyword: M60], March 12, 2002.
34. Jane's, *US Navy Announces DD(X) Programme*, Jane's Defence Industry, [<http://www.Janes.com> Keyword: DD 21], November 19, 2001.

35. Johnson, Michael V. R. Sr., McKeon, Mark F. and Szanto, Terence R., *Simulation Based Acquisition: A New Approach*, Defense Systems Management College, December 1998.
36. Keeter, Hunter, Weldon: *Nation Needs New Focus On Defense Readiness, Modernization*, Defense Daily International, November 23, 2001.
37. Kitfield, James, *Uncertainty In the Skies*, Government Executive Magazine, August, 1, 2001.
38. Krepinevich, Andrew, *The Bush Administration's Call for Defense Transformation: A Congressional Guide*, [<http://csbaonline.org/>], June 19, 2001.
39. Lockheed Martin, *Lockheed Martin Delivers First C-130J*, Press Release, August 24, 1998.
40. Loeb, Vernon and Bradley Graham, *Defense Budget: Tough Choices Skirted?* The Washington Post, February 10, 2002.
41. Loudon, J. Joseph, *Total Ownership Cost*, A Naval Sea Systems Command Power Point Presentation, Undated.
42. Lowe, Christian and David Brown, *Cost Overruns Could Derail Burgeoning Acquisition Programs: Congress Has Power to Cancel Costly Projects*, Marine Corps Times, April 29, 2002.
43. Mann, Paul, *Against Huge Odds, Faster Arms Acquisition*, Aviation Week & Space Technology, January 22, 2001.
44. Muradian, Vago and Wolfe, Frank, *Aldridge Seen As Frontrunner For Top DoD Acquisition Job*, Defense Daily, February 8, 2001.
45. Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates For FY 2003*, Department of Defense, March 2002.

46. Periscope, *Equipment Category: Aircraft–Fighter, F/A-18 E/F Super Hornet*, [<http://www.periscope.ucg.com/weapons/aircraft/fighter/-w0004547.html>], December 1, 1999.
47. Periscope, *Equipment Category: Aircraft–Helicopter, RAH-66 Comanche*, [<http://www.periscope.ucg.com/weapons/aircraft/rotory/-w0003077.html>], January 1, 2000.
48. Periscope, *Equipment Category: Ships–Destroyers, DD(X) Future Surface Combatant*, [<http://www.periscope.ucg.com/weapons/ships/destroyr/w0004665.html>], May 1, 2002.
49. Periscope, *Equipment Category: Ships–Submarines, Virginia (SSN-774) Class*, [<http://www.periscope.ucg.com/weapons/ships/subs/-w0004574.html>], May 1, 2002.
50. Phillips Business Information Corporation, *DoD Releases Joint Vision 2020 Guidance Document*, June 1, 2000.
51. Ruddy, John, *Help Is on the Way...or Is It?* Military News.com, February 21, 2001.
52. Scott, Richard, *Homing Instincts*, Babriet Tripod.com, 2002.
53. Shanker, Thom and Dao, James, *Defense Secretary Wants Cuts in Weapons Systems to Pay for New Technologies*, The New York Times, April 16, 2002.
54. Stevenson, Damon, *Block 30 Modifications to Begin on Pacer CRAG KC-135s*, Air Mobility Command Public Affairs, October 12, 1999.
55. *Systems Engineering Fundamentals*, Department of Defense Systems Management College, January 2001.
56. Thompson, Mark, *The Lessons of Afghanistan*, Inside Politics/CNN.com, February 11, 2002.
57. Tryszkiewicz, Mary and Stephen Daggett, *A Defense Budget Primer*, CRS Report for Congress, December 9, 1998.

58. United States Navy Fact File, *Torpedoes: Mark 46, Mark 48, Mark 50*,
[<http://www.chinfo.navy.mil/navpalib/factfile/weapons/wep-torp.html>], 2002.
59. Whitworth, Lloyd R., *Software Risk Management: A Case Study of the V-22 Program*, The Naval Postgraduate School, March 1996.

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